Fabrication of Silver Nanoparticles and Their Antimicrobial Mechanisms

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INTRODUCTION: Silver is one of the most universal antimicrobial substances. Nano-technogy enables us to expand the surface area of silver particles markedly. However, the exact mechanism of the antimicrobial effects of silver is still unknown. Therefore the antimicrobial activities and mechanisms of silver nanoparticles for several pathogenic bacteria were investigated.

METHODS: To synthesize nano-sized Ag colloid, silver nitrate as a source of silver was dissolved in ammonia water. Formaldehyde as a reducing agent and polyvinyl pyrrolidone (PVP) as the stabilizing agent were used. The temperature of the reaction vessel was maintained at 40 ºC, and the pH of reaction solution was maintained at 10 ± 0.5. PVP coated silver colloids were washed with acetone. Finally, the silver gel was centrifugally separated and washed with deionized water and then dried at 150ºC for 3 hours. To examine the bactericidal effect of silver nanoparticles on *Escherichia coli, Staphylococcus aureus, Salmonella typhi* and *Mycobacterium tuberculosis*, bacteria were incubated with a bead (0.1g) of silver and silver nanoparticles at a dilution of 0.5, 1, 5, 10 and 30 ppm for 1 hour. Then, bacteria were cultured on BHI agar plates and CFU was determined. Anti-tuberculosis activity of nanosilver was examined using the BACTEC MGIT 960. [1]To explore the antimicrobial mechanisms, several pathogenic bacteria cultured with nanosilver suspension for 1 hour were observed by TEM and SEM.

RESULTS: Silver nanoparticle was successfully produced less than 10nm in size (Fig. 1). It showed excellent antibacterial activities against *S. typhi, E. coil, P. aeruginosa* around 1 ppm and *S. aureus and M. tuberculosis* around 10 ppm. Three types of antimicrobial mechanisms were observed. 1) Plasmolysis, cytoplasm of bacteria separated from bacterial cell wall, was observed in Gram negative bacteria (Fig. 2). 2) The synthesis of bacterial cell wall was inhibited in *S. aureus.*

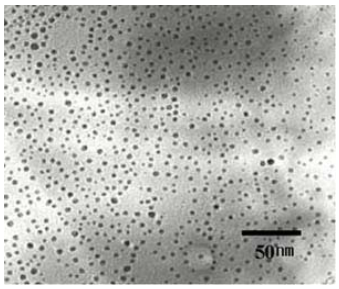

Fig. 1. TEM images of silver nanoparticles.

3) Nanosilver particles found in the cytoplasm of *M. tuberculosis* may induce metabolic disturbance.

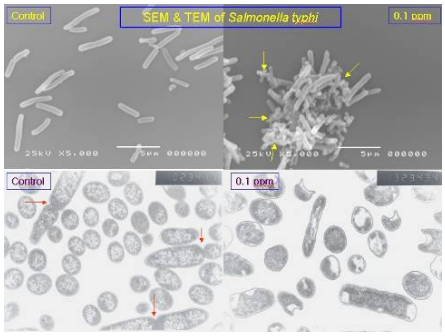

Fig. 2. Scanning (top) and transmission (bottom) electron micrographs of E. coli after treatment of 0.1 ppm of nanosilver for 1 hour.

DISCUSSION & CONCLUSIONS: Silver nanoparticle was successfully synthesized around 5 nm in size. They showed excellent antibacterial activity. Antimicrobial mechanisms of nanosilver were different according to the species of bacteria. From the result, Silver nanoparticles will be available as a good antibiotic alternative.

REFERENCES: [1] P.R Murray, K.S Rosenthal, et al (2002), Medical Microbiology, P 11-24, [2] I. Sondi, B.S. Sondi (2004), Journal of Colloid and Science Vol.275, p.177.

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