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Original Research Paper

Comparison of the anti-bacterial activity on the nanosilver shapes: Nanoparticles, nanorods and nanoplates

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A B S T R A C T

In this study, we comparison of the antimicrobial activity on the nanosilver shapes; Ag-nanoplates (Ag-NPls), Ag-nanorods (Ag-NRds) and Ag-nanoparticles (Ag-NPs). Nanosilver shapes were prepared with a stabilizer, such as poly (*N*-vinyl-2-pyrrolidone) (PVP). Antimicrobial effect of nanosilver shapes for *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*) was investigated using disc diffusion and minimum inhibitory concentration (MIC) methods. The growth of Gram-positive (*S. aureus*) and Gram-negative (*E. coli*) bacteria were inhibited by nanosilver shapes. With BET technique, it was found that surface area of nanosilver shapes are key factor for controlling antimicrobial activity inside of the *S. aureus* and *E. coli* bacteria. Anti-bacterial activity of nanosilver shapes was found to be dependent on the shape and size of silver particles. Also, the Ag-NPls did show the best surface area and antimicrobial activity for the test organisms. The scanning electron microscopy (SEM), indicated that, the most strains of *S. aureus* and *E. coli* were damaged and extensively disappeared by addition of Ag-NPls.

1. Introduction

Silver metal and its compound have been known to have strong inhibitory and bactericidal effects as well as a broad spectrum of antimicrobial activities [1,2]. Silver ions work against bacteria in a number of ways; silver ions interact with the thiol groups of enzyme and proteins that are important for the bacterial respiration and the transport of important substance across the cell membrane and within the cell [3] and silver ions are bound to the bacterial cell wall and outer bacterial cell, altering the function of the bacterial cell membrane [4], thus silver metal and its compounds were the effective preventing infection of the wound [5,6]. Silver metal was slowly changed to silver ions under our physiological system and interact with bacterial cells, thus silver ions will not be so high enough to cause normal human cells damage. Silver nanoparticles have a high specific surface area and a high fraction of surface atoms that lead to high antimicrobial activity compared to bulk silver metal [3]. Silver can inhibit enzymatic systems of the respiratory chain and alter DNA synthesis [7–9].

However, the antimicrobial effects of nanosilver shapes were not fully investigated. Metal nanoparticles (Me-NPs), which have a high specific surface area and a high fraction of surface atoms, have been studied extensively due to their unique physicochemical characteristics such as catalytic activity, optical properties, electronic properties, antimicrobial activity, and magnetic properties [10]. It can be expected that the high specific surface area and high fraction of surface atoms of nanosilver shapes will lead to high antimicrobial activity compared to bulk Ag metal. Recent, microbiological and chemical experiments implied that interaction of silver ion with thiol groups played an essential role in bacterial inactivation [11]. Surface area involves the increase of contact surface, which is an important condition for the effects of silver nanoparticles. Another reason for considering silver as superior is its broad antimicrobial activity [12].

We have recently developed a reduction method of converting Ag-nanospheres into nanorods [13] and nanoplates [14]. This method offers great ease of control and a high yield of hexagonal particles.

Herein, we report an improved anti-bacterial effect of hexagonal silver nanoparticles (Ag-NPs), silver nanorods (Ag-NRds) and silver nanoplates (Ag-NPls) that involves a number of steps:

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