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Antimicrobial Activity of Silver Nanoparticles Synthesized by Reduction Technique

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Silver metals have long been known to possess antimicrobial properties. Recently, Ag nanoparticles have also been proven as antimicrobials. In this work, Ag nanopartilces were synthesized by hydrazine hydrate. UV–vis absorption spectra, dynamic light scattering (DLS) and transmission electron microscopy (TEM) have been used to analysis the synthesis of silver nanoparticles. The antimicrobial activity of the Ag nanopartilces was tested against pathogenic *Escherichia coli*. The mechanism of Ag nanopartilces against *E. coli* may attribute to Ag nanopartilces leads to cell wall lysis and damages cell membrane integrity.

Keywords: Antimicrobial, Silver nanoparticles, *Escherichia coli*, Chemical synthesis.

Antibiotic resistance of pathogenic microorganisms has been increasing rapidly in recent years due to the massive use and abuse of conventional antibiotics[1]. Various studies have been focused on reduction of the use of conventional antibiotics as well as research for new antimicrobial components that are less potent in inducing antibiotic resistance. These study on new antimicrobials converged into metals and botanicals as possible alternatives. Several chemical forms of silver including silver metals have long been known to exhibit antimicrobial activities. Ag+ ion in the form of a silver nitrate solution has been the typical antimicrobial form. Current advances in technology and increased consumer demand for beneficial health materials are giving rise to many new products that use silver because of its highly effective antibacterial property[2]. Recently, the silver nanoparticles have also been shown to exhibit antimicrobial properties[3,4]. Mainly physical and chemical routes of synthesis are been utilized for the production of metallic nanoparticles to fulfil the demands of the industry. Generally, metal nanoparticles can be prepared and stabilized by chemical, physical and biological methods; the chemical approach, such as chemical reduction, electrochemical techniques, photochemical reduction and pyrolysis and physical methods, such as Arc-discharge and physical vapor condensation (pvc) is used. Living organisms have huge potential for the production of nanoparticles/ nanodevices of wide applications. However, the elucidation of the exact mechanism of nanoparticles production using living organisms needs much more experimentation[5,6,7].

In this paper, first we herein describe an easy synthetic route for silver nanoparticles by hydrazine hydrate as reducing agent. Then silver nanoparticles formed were characterized for their antimicrobial activity.

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MATERIALS AND METHODS

The Ag nanoparticles were synthesized using a chemical method by hydrazine hydrate. The size of the nanoparticles was established using Dynamic light scattering (DLS). The antimicrobial activity of the Ag nanoparticles against the Escherichia *coli* and *Staphylococcus aureus* were investigated by disc diffusion method. Briefly, the disc diffusion method was used to evaluate the antimicrobial activity of Ag nanoparticles against *S aureus* and *E coli.* This method was performed in LB medium solid agar Petri dish. The nanosilver shapes were cut into a disc shape with 1.5 cm diameter, sterilized by autoclaving 15 min at 120 ºC, and was placed on *E coli* cultured agar plate and *S aureus* cultured agar plate which were then incubated for 24 h at 37 ºC and inhibition zone was monitored After incubation the presence of bacterial growth inhibition halo around the samples were absorbed and their diameter in millimeters was measured.

RESULTS AND DISCUSSIONS

Formation of Ag nanoparticles was determined by UV–vis spectroscopy where surface plasmon absorption maxima can be observed at 415 nm from the UV–vis spectrum. UV-visible spectroscopy is a very powerful tool to monitor the synthesis of the silver nanoparticles as the metallic nanoparticles possess a property known as Surface Plasmon Resonance (SPR) which is primarily due to the oscillation of the free electrons present on the surface of the metallic nanoparticles when they are excited by any external energy source[8].

The main principle of the DLS study is that the particles undergo Brownian motion in the suspended liquid solution which measures the fluctuations in the intensity of the scattering light and by the application of stokes's-Einstein equation the Z-Average size (Hydrodynamic diameter) is obtained. Fig 2 shows the DLS pattern

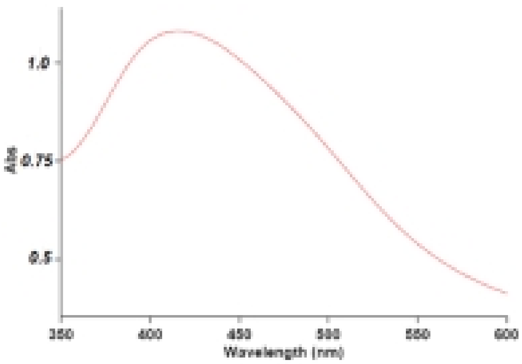

Fig. 1. UV–Visible spectrum of Ag nanoparticles

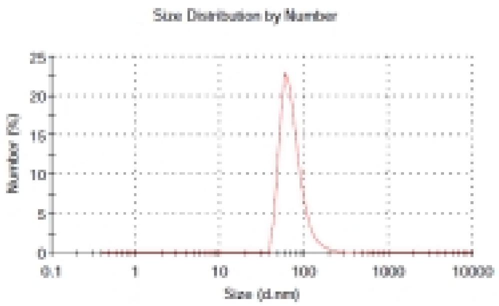

Fig. 2. A particle size distribution histogram of Ag nanoparticles

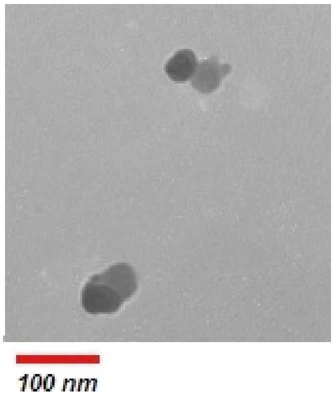

Fig. 3. TEM micrograph of Ag nanoparticles

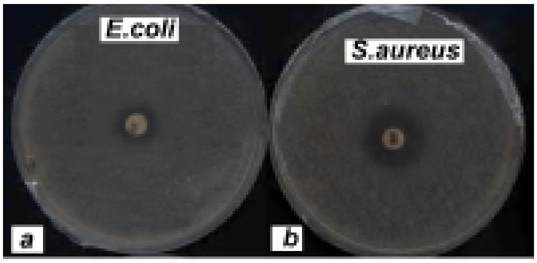

Fig. 4. Zone of inhibition by Ag nanoparticles against a) *E.coli* and b) *S. aureus*

of the synthesised Ag nanoparticles having a hydrodynamic size of 75± 30 nm, another aspect of DLS is the zeta potential study which gives the net surface charge of the nanoparticles when immersed in a solution. Transmission electron microscopy (TEM) revealed that Ag nanoparticles synthesized were in spherical shape (Fig 3). The antibacterial activity Ag nanoparticles for *Staphylococcus aureus* and *Escherichia coli* were measured by disk diffusion method. The Ag nanoparticles show high antibacterial activity. The growth inhibition ring of *S aureus* and *E coli* treated by Ag nanoparticles was 4 and 2 mm, respectively (Fig. 4).

CONCLUSIONS

Colloidal Ag nanoparticles were synthesized by hydrazine hydrate. The size of the silver nanoparticles was 75± 30 nm. In addition, the Ag nanoparticles show strong antibacterial activity. The growth inhibition ring of *S.aureus* and *E. coli* treated by Ag nanoparticles were 4 and 2 mm, respectively. The significance of these results is a demonstration that the Ag nanoparticles solutions have a good antibacterial activity for both *S. aureus* and *E. coli*.

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