Antibacterial activity of silver nanoparticles produced by Sesamum indicum seed extract on staphylococcus epidermidis and salmonella typhi

Taher mohasseli¹, Shahram pourseyedi²

¹. Member of Young Researcher Society, M Sc. student in Agricultural Biotechnology, Shahid Bahonar University of Kerman, Iran.
². Department of Agricultural Biotechnology, Shahid Bahonar University of Kerman, Iran.

*Corresponding author email: tahermohasseli3240@yahoo.com

ABSTRACT: The application of nanoscale materials and structures, usually ranging from 1 to 100 nanometers (nm), is an emerging area of nanoscience and nanotechnology. Nanosilver has been developed as a potent antibacterial, antifungal, anti-viral and anti-inflammatory agent. So far, a plenty of reports have introduced different factors that influence silver nanoparticle toxicity. Such factors are nanoparticle properties like particle size, shape, crystallization, surface chemistry and capping agents. As well as environmental factors like pH, ionic strength, presence of ligands and macromolecular interactions. In this work silver nanoparticles were synthesized using Sesamum indicum seed extracts. Synthesized nanoparticles were characterized using UV-visible spectrophotometer and Transmission Electron Microscopy (TEM). TEM imaging confirmed the capability of S. indicum seed extract for the synthesis of silver nanoparticles. The antibacterial activity of AgNPs was investigated on Gram-positive bacterium Staphylococcus epidermidis and Gram-negative bacterium Salmonella typhi, through serial dilution method using nutrient broth containing different concentrations of AgNPs. MIC (Minimum inhibitory concentration of growth) and MBC (Minimum bactericidal concentration) were determined.

Keywords: green synthesis, Silver nanoparticles, antibacterial activity, Staphylococcus epidermidis, Salmonella typhi, Sesamum indicum

INTRODUCTION

The search for components with antimicrobial activity has gained increasing importance in recent times, due to growing worldwide concern about the alarming increase in the rate of infection by antibiotic resistant microorganisms (Davis, 1982). The intrigue in nanomaterial research for regenerative medicine is easy to see and is wide spread. The potential benefits of nanomaterials in biomedical and industrial applications for human health and environment are now accepted in the literature (David et al., 2005; Lanone and Boczkowski, 2006). Silver has known to be a metal that came into use even before Neolithic revolution. The first recorded medicinal use of silver was reported during 8th century (Moyer, 1965). Nanotechnology as powerful tool for the creation of new objects in nanoscale dimensions, is a cutting edge technology having important applications in modern biomedical research (Parak, 2003; Gao, 2005; Alivisatos ,2004; Salata, 2004). So far several reports have discussed anti-fungal anti-inflammatory (Nadworny et al., 2010), anti-viral (Vaidyanathan et al., 2009 ), anti-angiogenesis (Kalishwaralal et al., 2009) and anti-platelet activity (Shrivastava et al., 2009) of silver nanoparticle.

Sesame belongs to the family Pedaliaceae and genus Sesamum (Purseglove, 1974 ). The genus consists of about 36 species of which 19 species are indigenous to Africa (Weiss, 1998; Uzo, 1998). Sesame plays an important role in human nutrition. Its seeds are used essentially for the production of oil, but also in the production of the paste (tehineh) and in food formulations such as Halaweh (sweetened tehineh), java beans and salads (Abou-Gharbia et al., 2000; Abu-Jdayil, Al-Malah, & Asoud, 2002; Namiki, 1995). In this study we Synthesized silver nanoparticles using tea seed extract from Sesamum indicum and determined its antibacterial against Staphylococcus epidermidis and Salmonella typhi.
MATERIALS AND METHODS

Bacterial strains and culture conditions

Staphylococcus epidermidis PTCC1114 and Salmonella typhi PTCC1609 were used for antimicrobial assay. Microbial manipulations were performed on Nutrient agar medium, with incubation at 37°C.

Plant material

Sesame seeds were obtained from selling companies seeds at Kerman, Iran and kept in sterilized screw-cap glass container.

Preparation of seed extract

Seed samples, 50gr, were surface sterilized using 30% sodium hypochlorite for 5 minutes and then rinsed, three times with sterile distilled water. Sterile water was added to disinfected seeds (2:1 V/V) and incubated 25°C temperature for 7 days. The prepared seed extract was filtered through 40 whatman filter paper and was kept in a refrigerator for further studies.

Synthesis of silver nanoparticles and Antibacterial assay

Silver nitrate (AgNO₃) was used as the source of the synthesis of silver nanoparticles. 5mL of the obtained seed extract was diluted by 15mL sterile water and was added to concentration of 1mM silver nitrate for the reduction of Ag⁺ to Ag⁰. Formation of silver nanoparticles from 1mM solution of silver nitrate was confirmed by using UV–vis spectral analysis. The tube dilution test were followed as for determining levels of resistance and sensitivity at from 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256 ml. Serial dilutions of the extract plant are made in a liquid medium which is inoculated with a standardized number of organisms and incubated for a prescribed time. The lowest concentration (highest dilution) of extract plant preventing appearance of turbidity is considered to be the minimal inhibitory concentration (MIC). Additionally, the minimal bactericidal concentration (MBC) can be determined by subculturing the contents of the tubes on to antibiotic-free solid medium and examining for bacterial growth.

RESULTS

During the nanoparticle biosynthesis using the extract the color of S. indicum solution changed rapidly from light greenish to dark yellowish brown due to Surface Plasmon Resonance. The absorption spectrum of yellowish brown solution containing silver nanoparticles showed a Surface Plasmon Resonance with a peak at 420nm (Figure 1).

Figure 2 is TEM image of sesame seed extract containing 1mM AgNO₃ solution at 30°C. It was shown that sesame seed extract produce silver nanoparticles which are often semi spherical. The silver nanoparticles showed Gaussian distributions with average diameter of 14 nm with some deviations. The morphology of silver nanoparticles is spherical which is in agreement with the shape of SPR band in the UV-vis spectrum.
Silver nanoparticles have attracted intensive research interest because of their important applications in antimicrobial, catalysis, and surface-enhanced Raman scattering (Li et al., 2006; Setua et al., 2007). For centuries, silver has been used as an antimicrobial agent. The recent resurgence in interest for this element particularly focuses on the increasing threat of antibiotic resistance, caused by the abuse of antibiotics (Panaek et al., 2006; Sandbhy et al., 2006). Silver ions can inhibit bacterial DNA replication, damage bacterial cytoplasm membranes, depleting levels of intracellular adenosine triphosphate (ATP) and finally cause cell death (Feng et al., 2000). In this study, the levels of MIC and MBC were observed at ranges 1.128 to 1.32 and 1.64 to 1.16 ml in radius respectively (Table 1). The least MIC value was observed against *Staphylococcus epidermidis* (1.32 ml) and the least MBC value was observed against *Staphylococcus epidermidis* (1.16 ml).

### DISCUSSION

Silver nanoparticles have attracted intensive research interest because of their important applications in antimicrobial, catalysis, and surface-enhanced Raman scattering (Li et al., 2006; Setua et al., 2007). For centuries, silver has been used as an antimicrobial agent. The recent resurgence in interest for this element particularly focuses on the increasing threat of antibiotic resistance, caused by the abuse of antibiotics (Panaek et al., 2006; Sandbhy et al., 2006). Silver ions can inhibit bacterial DNA replication, damage bacterial cytoplasm membranes, depleting levels of intracellular adenosine triphosphate (ATP) and finally cause cell death (Feng et al., 2000). In this study, the levels of MIC and MBC were observed at ranges 1.128 to 1.32 and 1.64 to 1.16 ml radius respectively (Table 1). The least MIC and MBC value was observed against *Staphylococcus epidermidis*. Silver nanoparticles of size 8 nm from leaves of *Nicotiana tobaccum* inhibits *Pseudomonas putida*, *P. vulgaris*, *Escherichia coli*, *B. subtilis*, *P. aeruginosa* and *Salmonella typhi* (Saranjit et al., 2011). AgNPs stabilized by Tulsi leaf extract were found to have enhanced antimicrobial activity against well-known
pathogenic strains, namely *Staphylococcus aureus* and *E.coli* (Ramteke et al., 2013), silver nanoparticles showed growth inhibition around the wells against the tested bacteria. Zoi of around 12.25 mm diameter was observed for the Gram positive bacterial strain *S. aureus* ATCC 25923. In case of Gram-negative bacterial strains *E. coli* ATCC 25922, *E.coli* ATCC 35218, and *P. aeruginosa* ATCC 27853, the detected zoi were 9.0, 8.0, and 11.0 mm, respectively (Kora et al., 2012). Recently, the synthesis of green AgNPs using biomass of *Cochliobolus lunatus* (Salunkhe et al., 2011). Similarly, other studies have shown that exposure of silver ions to *Trichoderma viride* (Fayaz et al., 2010) and *Escherichia coli* (Shahverdi et al., 2007) filtrate resulted in the reduction of silver ions and the formation of extremely stable silver nanoparticles. Jena et al.(2012) showed distinct differences in the susceptibility of bacteria to CS-AgNPs. *P. aeruginosa*, *S. typhi*, and *S. aureuswere* found to be more susceptible to the action of CS-AgNPs. In contrast, the inhibitory effect of nanoparticles was moderate in *M. smegmatis*. Several studies on the usage of metal nanoparticles in water filter have been carried out due to thier antibacterial properties (Jain et al., 2005). In an earlier report, the enhanced antibacterial potency of AgNPs was analyzed (Shrivastava et al., 2007). Recent report has demonstrated the therapeutic potential of AgNPs against leishmaniasis, another parasitic disease caused by Leishmania tropica (Allahverdiyev et al., 2011). In view of this, further studies are envisaged to explore the other potential applications of nanoparticles.

**REFERENCES**


