ABSTRACT

Metal nanoparticles (M-NPs) have captivated the interest of the scientific community in the realm of contemporary nanotechnology since their discovery by Faraday in 1857. Because of its remarkable features, it has attracted a lot of attention. The surface qualities such as greater surface area to volume ratio, surface charge, shape, size, crystallinity, and reactivity are some of the functional aspects of M-NPs. These properties enable them for applications in the field such as biosensors, imaging, drug delivery systems, conformational studies of biomolecules, cosmetics, foods, feeds, mechanics, electronics, energy devices, and medicinal applications. Considering above mentioned features of M-NPs in mind, current study aimed to develop gold nanoparticles using gentamicin through one-pot synthesis for antimicrobial applications. Furthermore, we also have tried to develop silver nanoparticles employing quercetin as reducing and stabilizing agent for sensing application.

One-pot synthesis of gold nanoparticles (G-AuNPs) was achieved by reacting gentamicin of 0.1 mM concentration with auric chloride of 2.5 mM concentration in 1:1 ratio. The optimum pH for the synthesis was 10 while optimum temperature for synthesis was 55 °C. UV-vis spectroscopy confirmed the synthesis of G-AuNPs and exhibited absorption maximum at 520 nm. Transmission electron microscopy (TEM) revealed that G-AuNPs were 13±3 nm in size with spherical in shape. The hydrodynamic size of G-AuNPs was found to be 15±3 nm by dynamic light scattering analysis (DLS). The synthesized G-AuNPs were found to exhibit synergistic antibacterial activity. The zone of inhibitions by G-AuNPs against *E. coli* ATCC 25922, *E. fergusonii* ATCC 35469, *E. coli* DH5α, and *S. aureus* MTCC 3160 were 15 mm, 14 mm, 11 mm, and 11 mm ($p>0.05$) respectively. The G-AuNPs were observed to had MIC of 0.01 nM, 0.046 nM, 0.0046 nM, and 0.0046 nM ($p>0.05$) towards *E. coli* ATCC 25922, *E. fergusonii* ATCC 35469, *E. coli* DH5α, and *S. aureus* MTCC 3160, respectively. *E. coli* DH5α, *E. coli* ATCC 25922, *E. fergusonii* ATCC 35469, and *S. aureus* MTCC 3160 displayed 4.0 %, 8.0 %, 9.0 %, and 9.0 %, respectively increase in ROS level due to G-AuNPs. Furthermore, there was 5.0 %, 6.0 %, 9.0 %, and 8.0 % increase in LPP level in *E. coli* DH5α, *E. coli* ATCC 25922, *E. fergusonii* ATCC 35469, and *S. aureus* MTCC 3160, respectively due to G-AuNPs treatment. Fluorescence intensity results revealed that the bacterial cells treated with G-AuNPs exhibited 13.0 %, 19.0 %, 23.0 %, and 35.0 % more intensity for *E. coli* ATCC 25922, *E. coli* DH5α, *S. aureus* MTCC 3160, and *E. fergusonii*

ATCC 35469 respectively as compared to untreated cultures. Drug release analysis revealed that release of gentamicin in the initial 8 h was maximum (37 %). However, after 8 h the release of drug molecules was persistent as only 53 % of drug was released at 72 h of time. MTT assay analysis revealed that there was negligible cytotoxicity of G-AuNPs and a survival of 92.0 % cells was recorded.

Furthermore, we have also synthesized silver nanoparticles (Q-AgNPs) using quercetin as reducing and stabilizing agent by reacting aqueous solution of silver nitrate (2 mM) and quercetin (50 µM) in 5:1 ratio at pH 10. X-ray diffraction analysis revealed the crystalline structure of Q-AgNPs. Fourier transformation infrared (FTIR) analysis revealed the quercetin functional groups on the Q-AgNPs surface. The electron microscopy (TEM and SEM) and DLS analysis revealed that Q-AgNPs were approximately 40 nm in size and spherical in shape. Stability analysis revealed that Q-AgNPs were stable from light acidic pH 6.5 to mild alkaline pH 8, sufficiently stable in electrolytes such as NaCl and KCl, and up to 50 °C. The synthesized Q-AgNPs were found to sense l-cysteine (L-Cys) and displayed 24 nm shift in the absorption maximum as compared to control along with transformation in Q-AgNPs colour from yellow to brown. L-Cys induced aggregation of Q-AgNPs was further confirmed by SEM, TEM and DLS analysis. Q-AgNPs were able to selectively sense L-Cys. Furthermore, the produced particles were able to detect water, urine and FBS solutions of L-Cys with detection limit of 21.1 nM, 86 nM, and 230 nM respectively. The estimation of sensitivity in complex fluids such as urine and FBS was a first attempt based on our understanding of the literature. As a result, our research offers a simple, low-cost, and fast way to detect L-Cys in water and biological complex fluids.

Thus, current work purposes simple, and robust method to produce G-AuNPs and Q-AgNPs. The G-AuNPs were found to have remarkable antimicrobial potential, whereas Q-AgNPs displayed themselves as excellent material for sensing. The finding from the study can be used to formulate new drug combinations and to produce materials with improved characteristics for sensing purpose.