Abstract

The synthesis of gold nanoparticles by chemical methods is a hazardous and not ecofriendly way, as it produces toxic chemicals. Hence, biological synthesis is considered an alternative, safe and ecofriendly method for the synthesis of AuNPs. The present study deals with the biosynthesis (from bacteria and fungi), optimization, characterization and antimicrobial activity of gold nanoparticles (AuNPs). Eighteen bacterial and 13 fungal strains were isolated from soil and food samples collected from different areas of Pakistan. The isolation was carried out by using the serial dilution method under aseptic conditions. The isolates were screened for the biosynthesis of AuNPs. Among all the isolates tested two bacterial isolates (BI-3 and BI-11) and three fungal isolates (FI-1, FI-3 and FI-8) gave positive results. BI-3 and FI-1 were found to be the best for the biosynthesis of AuNPs. UV-Vis spectroscopy analysis revealed that AuNPs synthesized by BI-3 and FI-1 showed a surface plasmon resonance peak at 530 nm. These particles were further characterized using FTIR spectroscopy and SEM analysis. Bacteriogenic gold nanoparticles were approximately 82.9 nm whereas myogenic AuNPs were 87.6 nm in size. To enhance the production of biomass various growth parameters such as culture medium, temperature and pH for selected microbes (BI-3 and FI-1) were optimized. The maximum growth of BI-3 was obtained in NB medium at 37°C and pH 7 whereas the FI-1 gave maximum growth in CDB at 30°C and pH 6. Moreover, the reaction parameters for the enhanced biosynthesis of AuNPs (biomass weight, incubation time, temperature, $HAuCl_4$ concentration and pH) were also optimized for both the bacteriogenic and mycogenic AuNPs. The optimum bacteriogenic AuNPs synthesis was obtained at 1 mM $HAuCl_4$, 48 hours of incubation, temperature 37°C, pH 8 and 50 mg biomass. Whereas, mycogenic AuNPs biosynthesis was maximum after 48 hours of incubation at 2 mM $HAuCl_4$ at 40°C, pH 7 and 5 gram biomass. Biosynthesized AuNPs showed antibacterial activity against *Staphylococcus aureus, Escherichia coli*, *Pseudomonas aeruginosa* and antifungal activity against *Aspergillus*

niger, Aspergillus fumigatus and *Aspergillus oryzae*. Bacteriogenic AuNPs depicted a synergistic effect with different antibiotics. The percentage fold increase in the antibacterial activity of ampicillin came out to be 53, 72 and 64%, doxycycline gave an overall percentage fold increase of 38, 28 and 33%, moxifloxacin manifested percentage fold increase of 26, 36 and 38%, vancomycin gave an increase of 33, 41 and 38%, tetracycline gave a percentage fold increase of 41, 38 and 47% and chloramphenicol manifested a percentage fold increase of 41, 43 and 44% when used in combination with AuNPs against S. *aureus, E. coli, P. aeruginosa*.