ABSTRACT

With its unparalleled potential for illness diagnosis, treatment, and monitoring, nanotechnology has become a ground-breaking tool in the medical industry. The objective of the present study was to address the rapidly increasing challenge of antimicrobial resistance by exploring the potential of metallic nanoparticles (MNPs), specifically silver nanoparticles (AgNPs) and zinc oxide nanoparticles (ZnO-NPs), as antibacterial agents. Innovative approaches of plant-based nanoparticles and nanoconjugates to enhance antibacterial activity were observed for antimicrobial resistance in bacteria, bacterial efflux pumps, and surface-functionalized nanoparticles for antibacterial activity. Furthermore, it explores the nanochemistry of turmeric, moringa, ciprofloxacin, and levofloxacin, shedding light on their potential as antibacterial agents. The biosynthesis and characterization of AgNPs and ZnO-NPs, Fourier transform infrared spectroscopy, size distribution mapping, UV-Vis spectroscopy, and scanning electron microscopy, bactericidal activity assessment, antioxidant activity, and efflux pump inhibition evaluation were evaluated. The findings underscore the potential of AgNPs and ZnO-NPs as effective antibacterial agents and efflux pump inhibitors, thereby offering novel strategies for combating antimicrobial resistance. AgNPs displayed a peak at 430 nm and ZnO-NPs an absorption edge at 371 nm. Conjugated AgNPs also showed peaks at 412 nm (LEV) and 420 nm (CIP). SEM analysis demonstrated the nanoparticles' size and form, which also revealed indications of agglomeration and aggregation in Tur-AgNPs and Moringa AgNPs. Conjugated AgNPs with CIP and LEV showed similar peaks, indicating conjugation success. The effectiveness of biologically generated AgNPs and ZnO-NPs against *S. aureus* and *E. coli* was demonstrated by bactericidal activity assessment, which showed different zones of inhibition. When antibiotics and MNPs were combined, synergistic effects were observed. Tur-AgNPs and Moringa AgNPs had the highest level of the DPPH radical scavenging activity. There was three times increase in ROS production in simple AgNP containing solution and four times increase in ROS production in ZnO-NPs containing solution as compared to control. Overall, the study illustrated the various uses and effectiveness of AgNPs and ZnO-NPs emphasizing their efflux pump inhibitory, antioxidant, and antibacterial qualities.