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Sustainable synthesis of Ag-ZnO nanocomposites utilizing pumpkin agro-waste and evaluation of their antioxidant potential

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The utilization of agro-waste for synthesizing nanocomposites (NCs) offers an eco-friendly method that supports sustainability and enables diverse applications in various industries. The study focused on the biosynthesis of Ag-ZnO NCs utilizing aqueous extracts of leaves (PL), peels (PP), and seeds (PS) waste from the Suprema F1 pumpkin variety and evaluated the antioxidant activities of each waste-mediated NCs. Optimal conditions were identified for synthesizing NCs with agro-waste extracts. UV-vis spectroscopy, FTIR, SEM, TEM, and XRD were used for the characterization of NCs. The antioxidant potential of NCs was assessed through DPPH, ABTS, and FRAP assays. The formation of Ag-ZnO NCs was confirmed by characteristic surface plasmon resonance peaks ranging from 350-475 nm. The involvement of the bioactive compounds as reducing, capping/stabilizing agents for the synthesis of NCs was evident in the FTIR spectra. SEM analysis showed that Ag-ZnO NCs contained spherical-shaped AgNPs aggregating on the nanoflower-shaped surfaces of ZnO. TEM analysis indicated particle size of NCs ranged from 20-86 nm. XRD analysis confirmed that Ag-ZnO NCs displayed high crystallinity, with the hexagonal wurtzite structure representing ZnO NPs and the face-centered cubic structure representing AgNPs. Concentration-dependent antioxidant activity was exhibited by the agro-waste-mediated NCs. Among them, PL-mediated Ag-ZnO NCs demonstrated the greatest antioxidant potential, exhibiting strong scavenging potent against DPPH and ABTS radicals, with IC_{50} values of 48.87 ± 2.90 ppm and 51.70 ± 2.00 ppm, respectively, and showed high FRAP scavenging power (138 ± 0.19 mg AAE/g) with equivalent to ascorbic acid. PS-mediated NCs exhibited diminished antioxidant activity when compared to PP and PL-mediated NCs. Consequently, biogenic NCs displayed the highest antioxidant activity than corresponding plant materials. The potential of pumpkin agro-waste as a valuable source for synthesizing Ag-ZnO NCs, which could serve as promising therapeutic agents by scavenging free radicals through their antioxidant properties.

Keywords: Ag-ZnO NCs, Ago-waste, Antioxidant activity, Eco-friendly, Suprema F1

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