Environmentally-Friendly Synthesis of Uncoated Silver Nanoparticles: Reduction of Negative Photosynthetic Effects of Commercial Nanoparticle Coatings

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Commercial silver nanoparticles (AgNPs) have industrial and commercial uses, and are serious environmental threats due to their synthetic coatings. Industrial-use AgNPs were synthesized and coated synthetically with trisodium citrate, while environmentally-friendly AgNPs lacking coatings were synthesized using tea extract. Spectral analysis confirmed the synthesis of AgNPs and showed similarities between both types. Antifungal assays confirmed their antimicrobial activities. Plants were exposed daily to AgNPs at a low concentration (10 ppm). After 45 days of growth, chloroplasts were analyzed to examine photosynthetic effects of AgNPs. Assays found chlorophyll concentrations and the attenuation coefficient of DPIP dye. The reduction rate of DPIP was used to analyze the efficiency of photosynthetic electron excitation. Leaf chads were analyzed in a sodium hydrogen carbonate solution to measure overall photosynthetic rate. Spectrophotometric analyses found that DPIP reduction rate was highest in plants exposed to uncoated AgNPs and lowest in plants exposed to coated AgNPs. The leaf chad experiment displayed similar findings, with uncoated AgNPs being significantly beneficial and coated AgNPs significantly detrimental to overall photosynthetic rate. Uncoated AgNPs reduced the negative photosynthetic effects of coated AgNPs and actually boosted photosynthetic rate; additionally, antifungal assays showed that uncoated AgNPs exhibited higher antimicrobial activity than coated AgNPs. Uncoated AgNPs also showed greater industrial value by reducing cost by a factor of 34. Thus, uncoated silver nanoparticles should be considered as an environmentally and economically advantageous alternative to coated AgNPs.

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