Synthesis and Characterization of Silver Nanoparticles for the Detection of Heavy Metals

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Traditional detection methods for heavy metals in groundwater often lack the sensitivity and efficiency needed for real-time monitoring, making the development of portable and sensitive detection techniques crucial for timely contamination identification and remediation. Silver nanoparticles (AgNPs) have emerged as promising sensing agents due to their unique optical and catalytic properties, and 8-hydroxyquinoline-5-sulfonic acid (8Q5S)-capped AgNPs offer enhanced stability, selectivity, and sensitivity, making them suitable for on-site monitoring applications. This study evaluates the efficiency of 8Q5S-capped AgNPs compared to AgNPs synthesized using the Turkevich method for detecting Pb(Ⅱ), Al(Ⅲ), and Hg(Ⅱ) in groundwater. The 8Q5S-capped AgNPs were synthesized and characterized using UV-Vis spectroscopy to confirm their size, morphology, and stability. Groundwater samples from contaminated sites were spiked with known metal concentrations to simulate environmental conditions, and detection was performed through colorimetric assays, with absorbance measurements at specific wavelengths corresponding to each metal ion. Results demonstrated that 8Q5S-AgNPs outperformed other AgNP samples in detecting heavy metals, though all struggled with mercury detection. This research advances environmental monitoring by assessing the sensitivity, selectivity, and practical applicability of 8Q5S-capped AgNPs. Their enhanced performance supports more efficient groundwater monitoring and sustainable resource management, offering a viable solution for rapid heavy metal detection.

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