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Synthesis of Copper Nanoparticles with Various Sizes and Shapes: Application as a Superior Non-Enzymatic Sensor and Antibacterial Agent

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Copper nanoparticles (CuNPs) play an important role in optics, electronics, and antimicrobial fields. In this work we reported, synthesized CuNPs with various sizes and shapes by a facile chemical reduction of copper nitrate $Cu(NO_3)_2$ solution using isopropyl alcohol (IPA) as a reducing agent and cetyltrimethyl ammonium bromide (CTAB) as a capping agent. The relationships between the $Cu(NO_3)_2$ and CTAB concentration ratios and the size of the CuNPs were elucidated by optical measurements. It was found that at a high CTAB concentration, hexagonal CuNPs were formed. In contrast, at a high concentration of copper nitrate, spherical CuNPs were formed in aggregations. From the TEM analysis, it was found that the CuNPs exhibit three different sizes (16, 23, and 37 nm), which displayed characteristic adsorption bands at 551-572 nm. The electrocatalytic activities of the CuNPs with different sizes and shapes towards H_2O_2 were systematically explored, and it was found that the electrocatalytic activity was strongly dependent on the microstructure of CuNPs, through changing the oxidation current values of the CuNPs. The cyclic voltammetry results showed that ratio 1:2 CTAB: $Cu(NO_3)_2$ exhibited good electrocatalytic activity than other ratios. Furthermore, the proposed sensor demonstrated significant antibacterial activities against gram-negative (*E. coli*) more than gram-positive (*S. aureus*) bacteria. In summary, this work demonstrates a facile, economic and fast method for the fabrication of copper nanoparticles with high catalytic activity using CTAB/IPA, which have potential as a non-enzymatic sensor for H_2O_2 detection and could be used in biomedical applications.

Keywords: Copper nanoparticle; CTAB; Modified electrode; Electrochemistry; H_2O_2 detection; Antimicrobial.

FULL TEXT