A Novel 3D Polymeric Nanoparticle Network for Detecting and Remediating Trace Level Toxic Free Radicals (Propagators and Precursors of Chronic and Degenerative Diseases)

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More than 60% of yearly deaths are caused by chronic and degenerative diseases such as cardiovascular, cancer, Alzheimer's and diabetes. Overexpressed free radicals are the precursors and propagators of these diseases, urging the need for trace level detection and biocompatible remediation of free radicals. Gold-based nanoparticles show promise in literature. However, they cause cell damage by accumulated metal ions, lack biocompatibility, and lower free radical quenching efficiency due to inadequate surface area. This research designed novel nanoparticle consisting of biocompatible poly-l-histidine hydrochloride reagent bio-synthesized with clove flavonoid. This enhanced quenchability, enabling simultaneous trace level free radical detection and remediation. Electron-deficient imidazole side group in poly-l-histidine initiated nucleophilic attack with OH- containing eugenol functional group leading to steric hindrance of imidazole. This resulted in bulky N-site of imidazole, forming high surface area three-dimensional network. Reaction mechanism was justified by open-source computational thermodynamics software. TEM and SEM images evidenced uniform three-dimensional network formation as opposed to spherical gold nanoparticles. Hydroxyl free radicals detected by Electron Paramagnetic Resonance (EPR) diminished reacting with invention nanoparticle, suggesting near-perfect quench. Quenching was validated by UV-Visible spectra. Additionally, free radical voltage dropped 93% by poly-l-histidine and 45% with gold providing 47% extra detectability with measured oscilloscopic voltage. Furthermore, a highly sensitive, accessible, and cost-effective household digital device invented on Arduino Uno© platform utilizing invention nanoparticle was for early detection of diseases.

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