Novel Synthesis of Water-Soluble Paramagnetic Polymer Nanoparticles (Metal Free) for Selective Drug Delivery and Cancer Therapy Applications

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Iron oxide based superparamagnetic nanoparticles have the potential for revolutionary breakthroughs in applications such as selective drug delivery or cancer therapy because of the guidance by external magnetic field. However, metallic nanoparticles are severely limited by reactive oxygen species generation, ion migration, and long-term residence in body without degradation causing cell viability plummeting as low as 0% to 20% evidenced by a clinical study by Keenan et al. This research proposed the first ever synthesis of water soluble completely biocompatible polymers with induced paramagnetic properties at room temperature. An innovative methodology with argon plasma treatment in the presence of polycarbonate created p-topology on the polymer backbone, and a charge complexation reaction with a water soluble electron acceptor facilitated ferromagnetic coupling and lone electron spin. A flavonoid based green reduction process created paramagnetic polymer nanoparticles. Iron (Fe) and nickel (Ni) based nanoparticles were generated as a baseline. SEM/TEM images showed an average of 22 nm and 35 nm for polyvinyl alcohol (PVA), a representative polymer, and Fe nanoparticles, respectively. EDS verified fully organic identity of magnetic polymer nanoparticles. Magnetic susceptibility study with NMR using the Evans Method showed a susceptibility of 4.67 x 10^-4 dm^3/mol for PVA, 24.5% higher than Ni nanoparticles, and Fe nanoparticles showed an order of magnitude higher susceptibility at 7.80 x 10^-3 dm^3/mol . This novel paramagnetic polymer synthesis could hold the key to limitless applications in countering negative effects of metals and potentially revolutionize the field of nanoscience in biological applications.

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