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Synthesis of Multi-Functional Iron Oxide Nanoparticles for Targeted Drug Delivery in Cancer Treatment

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Abstract : Significant number of studies and preclinical research in formulation of cancer nano-pharmaceutics have led to an improvement in cancer care. Nonetheless, the antineoplastic agents have 'failed to live up to its promise' since their clinical performance is moderately low. For almost ninety years, iron oxide nanoparticles (IONPS) have managed to keep its reputation in clinical application due to their low toxicity, versatility and multi-modal capabilities. Drug Administration approved utilization of IONPs for diagnosis of cancer as contrast media in magnetic resonance imaging, as heat mediator in magnetic hyperthermia and for the treatment of iron deficiency. Furthermore, IONPs have high drug-loading capacity, which makes them good candidates as therapeutic agent transporters. There are yet challenges to overcome for successful clinical application of IONPs, including stability of drug and poor delivery, which might lead to (i) drug resistance, (ii) shorter blood circulation time, and (iii) rapid elimination and adverse side effects from the system. In this study, highly stable and super paramagnetic IONPs were prepared for efficient and targeted drug delivery in cancer treatment. The synthesis procedure was briefly involved the production of IONPs via co-precipitation followed by coating with tetraethyl orthosilicate and 3-aminopropylethoxysilane and grafting with folic acid for stability targeted purposes and controlled drug release. Physiochemical and morphological properties of modified IONPs were characterised using different analytical techniques. The resultant IONPs exhibited clusters of 10 nm spherical shape crystals with less than 100 nm size suitable for drug delivery. The functionalized IONP showed mesoporous features, high stability, dispersibility and crystallinity. Subsequently, the functionalized IONPs were successfully loaded with oxaliplatin, a chemotherapeutic agent, for a controlled drug release in an actively targeting cancer cells. FT-IR observations confirmed presence of oxaliplatin functional groups, while ICP-MS results verified the drug loading was ~ 1.3%.

Keywords : cancer treatment, chemotherapeutic agent, drug delivery, iron oxide, multi-functional nanoparticle
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