Synthesis of an Electromagnetically-Controlled Corn-Starch/PVA Biopolymer Microcube for Extended and Targeted Drug Delivery

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There has been recent focus on water-soluble polymer matrices with integrated protein or starch bases to increase mechanical characteristics of extended-release drug delivery devices. Unfortunately, a biocompatible, dissolvable micro-carrier that can be maneuvered throughout the body has rarely been researched despite its potential for extended-release and targeted drug delivery. This research proposes the novel synthesis of a water-soluble cornstarch/PVA biopolymer matrix embedded with microclusters of iron colloidal spheres for subcutaneous maneuverability via external electromagnetic fields. Biopolymer films were synthesized with a 2:3 ratio of PVA (Mw-100,000) to cornstarch, using modified methods from Othman et. al. Fe_3O_4 magnetic nanoparticles (NP's) were prepared by co-precipitation of ferric and ferrous ions in an aqueous ammonia solution under N_2-atmosphere. Resultant NP's were then coated with PVA to ensure homogeneous mixing of colloidal spheres with the biopolymer, which was molded using a printed three-dimensional template. Coating of the biopolymer matrices were supported by FTIR/SEM analyses. Anticancer chemotherapy drug, doxorubicin hydrochloride (DOX), was loaded onto the PVA/Fe_3O_4 NP's. DOX loading, and subsequent release into aqueous medium (to mimic drug delivery), was quantified using the drug's native fluorescence at 553/590nm, with a 230nm excitation. 1.2µg DOX/mg PVA/Fe_3O_4 loading was achieved in as little as 5days, with as much as 75% release of the drug in only 50hours, into slightly acidic aqueous medium at 37°C. 100mm^3 cornstarch/PVA films with embedded DOX/PVA/Fe_3O_4 colloidal-NP's were constructed, and found to be magnetically motorized and water soluble over 7hours, for release of the DOX load in ~1day from mimicked tumor-site localization.