The Design and Evaluation of a Tumor Microenvironment-Responsive Mesoporous Silica Nanoparticle for Enhanced Drug Delivery in Colon Cancer

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Chemotherapy remains the foundation for cancer treatments but is limited by significant side effects resulting from its nonspecific cytotoxicity. In order to counteract this, delivery systems based on nanoparticles offer a potential alternative that can enhance the effectiveness of chemotherapy while lowering its adverse effects. This study investigates doxorubicin-loaded mesoporous silica nanoparticles (MSNs) conjugated with folic acid, polyethylenimine (PEI), and calcium carbonate for targeted cancer therapy. Specifically, the purpose of this study was to assess the nanoparticles' efficacy in decreasing the viability of HCT-116 colon cancer while minimizing the impact on primary colon cells. Healthy and cancerous colon cells were cultured and seeded into 96-well plates. Nanoparticles were then conjugated with folic acid, PEI, and calcium carbonate, followed by characterization using scanning electron microscopy and zeta potential measurements. Cells were treated with nanoparticle concentrations ranging from 50 to 200 µg/mL, and viability was measured utilizing an alamarBlue assay at 24 and 72 hour time points. Results demonstrated that nanoparticles at 200 µg/mL caused significant apoptosis in HCT-116 cells by decreasing viability by 70% after 72 hours while doxorubicin alone decreased viability by 40%. Furthermore, all concentrations of nanoparticles showed minimal cytotoxicity toward primary colon cells while doxorubicin decreased their viability by 30% after 72 hours. These results demonstrate the potential of utilizing these MSNs as a safer, smarter, and more precise alternative to conventional chemotherapy. Overall, these nanoparticles can be used to significantly advance the field of personalized medicine and bring safer treatments to patients around the world.

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