National University of Science and Technology POLITEHNICA Bucharest

Doctoral School of Chemical Engineering and Biotechnologies

Abstract Ph.D. Thesis

Polymeric biomaterials with special applications

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Abstract

The aim of this doctoral thesis focuses on the development of new drug delivery systems utilizing biopolymers with medical applications. These systems consist of vehicles such as nanoparticles to transport therapeutics with the aim of enhancing drug solubility, minimizing toxicity, extending circulation time, restricting bio-distribution, attaining specific targeting, and reducing immunogenicity. The newly developed pharmaceutical delivery platforms aim to address the challenges associated with conventional drug delivery in the field of cancer therapy. This thesis delineates the methodologies employed in the development of drug delivery systems, characterization methodologies and the resultant findings. Additionally, the thesis includes strategies detailing the functionalization of electrochemical sensors tailored for detecting drugs employed in cancer therapy.

The biocompatibility of silk fibroin was highlighted as a vital element demonstrating its potential in the advancemed of nanocarriers for the adequate release of 5-FU for colon cancer treatment. The development of polymeric nanocarriers based on silk fibroin (SF) chemically modified with polyethylene glycol (PEG) as a drug delivery approach were addressed in this work. The enhancement of therapeutic efficacy for encapsulated anti-cancer drug 5-fluorouracil (5-FU) was pursued through the modification of particle size, chemistry, drug release and biological properties via PEG functionalization of the SF nanoparticles. This innovative drug delivery system, derived from the bonding of silk fibroin with PEG, showed strong biocompatibility with adenocarcinoma cells (HT-29) and biocompatibility with human blood cells.

Another type of drug delivery system was obtained by surface-modified silk fibroin nanoparticles for protection of anticancer drugs in the gastrointestinal tract. This system involved surface-modified SF loaded with 5-fluorouracil and enclosed within a chitosan/polyvinyl alcohol outer capsule, serving to shield the drug from degradation while traversing the gastrointestinal tract. Physicochemical characterization methods, including FT-IR, XPS and CD spectroscopy, were made use of to confirm the success of the modification steps and structural adjustments throughout the coupling reactions. Biocompatibility results showed a considerable impact on HT-29 cells after exposure to the SF platform and 5-FU therapy. These findings suggest that the developed platforms, particularly the 5% concentration variant, offer promising potential for targeted drug delivery to the colon while mitigating premature release in the stomach.

Sensors manufactured by using screen-printed electrodes are extremely precise and selective in detecting diverse analytes. The last study of this thesis not only sheds light on the effectiveness of different cleaning methods, but also underlines the importance of customized cleaning approaches for screen-printed electrodes. Also, two prototype sensors for detecting two typically used antitumor agents, cisplatin and bleomycin, in cancer therapy within biological samples were developed. The cisplatin biosensor had a quantification limit of 0.6 μg/mL, whereas the bleomycin biosensor had a quantification limit of 0.23 μg/mL. The both biosensors need performance improvement and a future perspective is to develop SPEs for continuous monitoring of drugs concentration within biological samples to minimize the potential for side effects.