Abstract

Infections by antibiotic-resistant microorganisms are developing into a major clinical problem globally, causing a significant increase in morbidity and mortality. Due to the significantly high resistance of new strains of pathogens, available courses of treatment are often ineffective, with their effectiveness being reduced constantly. Nanomedicine has the potential to present new, revolutionary solutions to this problem, mainly through the encapsulation of antibiotic drugs in nanoparticles, allowing for more reliable and effective transfer of a sufficient therapeutic concentration of antibiotics at the heart of the infection, which will lead to eradication of the infection before development of resistance by the pathogens is possible. On a parallel note, the combination of the field of phytopharmaceutical agents and that of nanomedicine, has attracted significant interest from the scientific community lately. Phytopharmaceutical substances often present significant beneficial actions, but their use is hampered by their low bioavailability. Nanomedicine, through the encapsulation of these agents in nanoparticles, can help ensure higher bioavailability, enabling these agents to yield their beneficial actions, without being hampered by the innate problems their molecules present. In the experimental part of this thesis, multiple nanoparticle formulations were created with the electrospraying method. Some of the dispersions were loaded with the antibiotic drug Ciprofloxacin, whereas others were loaded with the phytopharmaceutical agents Cannabidiol and Curcumin. The nanoparticles were characterized morphologically with the AFM and SEM techniques. An optimization procedure was then conducted by adjusting the electrospraying parameters during the nanoparticle formulation step, based on the morphology results that were extracted with AFM/SEM, to eventually produce nanoparticles with the best possible morphology. The nanoparticles' ability to be loaded with the active agents was then examined, followed by the mechanism and duration by which the active agents were released from the nanoparticles' interior to a dilution medium. The cytocompatibility of the nanoparticles was also examined, by testing the ability of cells to proliferate on a surface covered with the nanoparticles. The Ciprofloxacin-loaded nanoparticles were added as an antimicrobial coating on an indwelling catheter, with the aim of producing a catheter that will be able to resist and combat resistant microbial infections of the urinary tract. The catheter's nanoparticle coating was examined with optical microscopy, to check its uniformity on a catheter-wide scale, and with AFM to check for nanoparticle integrity after being sprayed on the catheter. The Cannabidiol-loaded nanoparticles were added as an ingredient in an anti-inflammatory cream, to produce a cream that would make use of the properties of Cannabidiol to help cure pain on the skin and subcutaneous tissues or ligaments. Samples of the cream were tested with AFM and SEM microscopy to check for successful addition of the nanoparticles and to check for their integrity and stable morphology after being added. The results of all studies conducted herein show the successful formulation of several different drug-loaded and phytopharmaceutical-loaded nanoparticle dispersions, and the successful creation of two experimental nanomedicine products, with promising results in utilizing nanoparticles against resistant infections, and in the utilization of active phytopharmaceutical agents via nanomedicine.