Nanotechnology-Based Implantable Drug Delivery: Characterization of Electrospun Temozolomide-Cellulose Acetate Nanofibers

Implantable Drug Delivery Systems (IDDS) using nanobiotechnologies offer targeted and sustained drug release by delivering therapeutics directly into the body. This study describes the preparation of electrospun cellulose acetate (CA) nanofibers as sophisticated biomaterials enabled with temozolomide (TMZ), a common anticancer drug used in treating brain tumors, including glioblastoma. Cellulose acetate (CA) nanofibers loaded with TMZ were synthesized by electrospinning using CA at a constant concentration of 17% (w/v) and with different TMZ loadings (5 mg, 10 mg and 15 mg). Electrospun TMZ–CA nanofiber membranes were comprehensively characterized by scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), and ultraviolet-visible spectrophotometer (UV-Vis). SEM analysis confirmed uniform, bead-free fibers with increasing diameter as TMZ concentration increased. FTIR and UV-Vis spectroscopy analysis confirmed that TMZ retained its stability and molecular integrity within the cellulose acetate (CA) matrix following fabrication. Also, sessile drop contact angle studies showed hydrophobicity (angles above 90°), indicating continued drug release. In vitro drug release studies using phosphate-buffered saline (PBS) revealed biphasic release profiles, with 22-26% of the drug released within 8 hours, suggesting sustained delivery potential. The study illustrates the possibilities of using functional nanomaterials, in this case, electrospun TMZ-loaded CA nanofibers. They retain the stability of the drug, sustain release properties, and provide appropriate surface characteristics. This study highlights the potential of IDDS in cancer therapy, paving the way for future in-vivo experiments and clinical applications of nanotechnology-based implantable devices.