

Characterization and in vitro studies of the anticancer effect of oxidized carbon nanotubes functionalized with betulinic acid

Abstract

Among the array of nanomaterials, carbon nanotubes have shown great potential as drug carriers in the field of nanomedicine, owing to their attractive physicochemical structure, which facilitates functionalization of therapeutic molecules onto their external walls or being encapsulated inside the tubes. The aim of this preliminary study was to formulate betulinic acid (BA), a poorly water-soluble drug, in oxidized multiwalled carbon nanotubes (MWCNT-COOH) for enhanced delivery efficiency into cancer cells with reduced cytotoxicity. The synthesized MWCNT-BA nanocomposite was characterized using ultraviolet-visible, Fourier transform infrared, thermogravimetric analysis, powder X-ray diffraction, and field emission scanning electron microscopy techniques. The loading of BA in MWCNT-COOH nanocarrier was estimated to be about 14.5%–14.8% (w/w), as determined by ultraviolet-visible and thermogravimetric analysis. Fourier transform infrared study shows that the peaks of the resulting MWCNT-BA nanocomposite correlate to the characteristic functional groups of BA and MWCNT-COOH. The powder X-ray diffraction results confirmed that the tubular structures of MWCNT-COOH were not affected by the drug loading mechanism of BA. The release profiles demonstrated that approximately 98% of BA could be released within 22 hours by phosphate-buffered saline solution at pH 7.4 compared with about 22% within 24 hours at pH 4.8. The biocompatibility studies revealed that MWCNT-BA at concentrations <50 µg/mL expressed no cytotoxicity effects for mouse embryo fibroblast cells after 72 hours of treatment. The anticancer activity of MWCNT-BA was observed to be more sensitive to human lung cancer cell line when compared with human liver cancer cell line, with half maximal inhibitory concentration values of 2.7 and 11.0 µg/mL, respectively. Our findings form a fundamental platform for further investigation of the MWCNT-BA formulation against different types of cancer cells.

Keyword: Multiwalled carbon nanotubes (MWCNTs); Drug delivery; Controlled release; Cytotoxicity; A549 cell line; HepG2 cell line