Anticancer nanodelivery system with controlled release property based on protocatechuate–zinc layered hydroxide nanohybrid

ABSTRACT

Background: We characterize a novel nanocomposite that acts as an efficient anticancer agent. Methods: This nanocomposite consists of zinc layered hydroxide intercalated with protocatechuate (an anionic form of protocatechuic acid), that has been synthesized using a direct method with zinc oxide and protocatechuic acid as precursors. Results: The resulting protocatechuic acid nanocomposite (PAN) showed a basal spacing of 12.7 Å, indicating that protocatechuate was intercalated in a monolayer arrangement, with an angle of 54° from the Z-axis between the interlayers of the zinc layered hydroxide, and an estimated drug loading of about 35.7%. PAN exhibited the properties of a mesoporous type material, with greatly enhanced thermal stability of protocatechuate as compared to its free counterpart. The presence of protocatechuate in the interlayers of the zinc layered hydroxide was further supported by Fourier transform infrared spectroscopy. Protocatechuate was released from PAN in a slow and sustained manner. This mechanism of release was well represented by a pseudo-second order kinetics model. PAN has shown increased cytotoxicity compared to the free form of protocatechuic acid in all cancer cell lines tested. Tumor growth suppression was extensive, particularly in HepG2 and HT29 cell lines. Conclusion: PAN is suitable for use as a controlled release formulation, and our in vitro evidence indicates that PAN is an effective anticancer agent. PAN may have potential as a chemotherapeutic drug for human cancer.

Keyword: Protocatechuic acid; Nanocomposite; Zinc layered hydroxide; Zinc oxide; 3T3; HepG2; HeLa; HT29