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Magnetic Carriers of Organic Selenium (IV) Compounds: Physicochemical Properties and Possible Applications in Anticancer Therapy

Authors : E. Mosiniewicz-Szablewska, P. Suchocki, P. C. Morais

Abstract : Despite the significant progress in cancer treatment, there is a need to search for new therapeutic methods in order to minimize side effects. Chemotherapy, the main current method of treating cancer, is non-selective and has a number of limitations. Toxicity to healthy cells is undoubtedly the biggest problem limiting the use of many anticancer drugs. The problem of how to kill cancer without harming a patient can be solved by using organic selenium (IV) compounds. Organic selenium (IV) compounds are a new class of materials showing a strong anticancer activity. They are first organic compounds containing selenium at the +4 oxidation level and therefore they eliminate the multidrug-resistance for all tumor cell lines tested so far. These materials are capable of selectively killing cancer cells without damaging the healthy ones. They are obtained by the incorporation of selenous acid (H2SeO3) into molecules of fatty acids of sunflower oil and therefore, they are inexpensive to manufacture. Attaching these compounds to magnetic carriers enables their precise delivery directly to the tumor area and the simultaneous application of the magnetic hyperthermia, thus creating a huge opportunity to effectively get rid of the tumor without any side effects. Polylactic-co-glicolic acid (PLGA) nanocapsules loaded with maghemite (□-Fe2O3) nanoparticles and organic selenium (IV) compounds are successfully prepared by nanoprecipitation method. In vitro antitumor activity of the nanocapsules were evidenced using murine melanoma (B16-F10), oral squamos carcinoma (OSCC) and murine (4T1) and human (MCF-7) breast lines. Further exposure of these cells to an alternating magnetic field increased the antitumor effect of nanocapsules. Moreover, the nanocapsules presented antitumor effect while not affecting normal cells. Magnetic properties of the nanocapsules were investigated by means of dc magnetization, ac susceptibility and electron spin resonance (ESR) measurements. The nanocapsules presented a typical superparamagnetic behavior around room temperature manifested itself by the split between zero field-cooled/field-cooled (ZFC/FC) magnetization curves and the absence of hysteresis on the field-dependent magnetization curve above the blocking temperature. Moreover, the blocking temperature decreased with increasing applied magnetic field. The superparamagnetic character of the nanocapsules was also confirmed by the occurrence of a maximum in temperature dependences of both real □′(T) and imaginary □′′ (T) components of the ac magnetic susceptibility, which shifted towards higher temperatures with increasing frequency. Additionally, upon decreasing the temperature the ESR signal shifted to lower fields and gradually broadened following closely the predictions for the ESR of superparamagnetoc nanoparticles. The observed superparamagnetic properties of nanocapsules enable their simple manipulation by means of magnetic field gradient, after introduction into the blood stream, which is a necessary condition for their use as magnetic drug carriers. The observed anticancer and superparamgnetic properties show that the magnetic nanocapsules loaded with organic selenium (IV) compounds should be considered as an effective material system for magnetic drug delivery and magnetohyperthermia inductor in antitumor therapy.

Keywords : cancer treatment, magnetic drug delivery system, nanomaterials, nanotechnology
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