Surface-functionalized cockle shell–based calcium carbonate aragonite polymorph as a drug nanocarrier

ABSTRACT

Calcium carbonate aragonite polymorph nanoparticles derived from cockle shells were prepared using surface functionalization method followed by purification steps. Size, morphology, and surface properties of the nanoparticles were characterized using transmission electron microscopy, field emission scanning electron microscopy, dynamic light scattering, zetasizer, X-ray powder diffraction, and Fourier transform infrared spectrometry techniques. The potential of surface-functionalized calcium carbonate aragonite polymorph nanoparticle as a drug-delivery agent were assessed through in vitro drug-loading test and drug-release test. Transmission electron microscopy, field emission scanning electron microscopy, and particle size distribution analyses revealed that size, morphology, and surface characterization had been improved after surface functionalization process. Zeta potential of the nanoparticles was found to be increased, thereby demonstrating better dispersion among the nanoparticles. Purification techniques showed a further improvement in the overall distribution of nanoparticles toward more refined size ranges <100 nm, which specifically favored drug-delivery applications. The purity of the aragonite phase and their chemical analyses were verified by X-ray powder diffraction and Fourier transform infrared spectrometry studies. In vitro biological response of hFOB 1.19 osteoblast cells showed that surface functionalization could improve the cytotoxicity of cockle shell–based calcium carbonate aragonite nanocarrier. The sample was also sensitive to pH changes and demonstrated good abilities to load and sustain in vitro drug. This study thus indicates that calcium carbonate aragonite polymorph nanoparticles derived from cockle shells, a natural biomaterial, with modified surface characteristics are promising and can be applied as efficient carriers for drug delivery.

Keyword: Cockle shell; Calcium carbonate; Aragonite; Surface functionalization; Nanoparticle; Drug delivery