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Synthesis, characterization, and cytocompatibility of potential cockle shell aragonite nanocrystals for osteoporosis therapy and hormonal delivery

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Abstract

Calcium carbonate is a porous inorganic nanomaterial with huge potential in biomedical applications and controlled drug delivery. This study aimed at evaluating the physicochemical properties and in vitro efficacy and safety of cockle shell aragonite calcium carbonate nanocrystals (ANC) as a potential therapeutic and hormonal delivery vehicle for osteoporosis management. Free and human recombinant parathyroid hormone 1-34 (PTH 1-34)-loaded cockle shell aragonite calcium carbonate nanocrystals (PTH-ANC) were synthesized and evaluated using standard procedures. Transmission electron microscopy and field emission scanning electron microscopy results demonstrated highly homogenized spherical-shaped aragonite nanocrystals of 30±5 nm diameter. PTH-ANC had a zeta potential of −27.6±8.9 mV. The encapsulation efficiency of the formulation was found to be directly proportional to the concentrations of the drug fed. The X-ray diffraction patterns revealed strong crystallizations with no positional change of peaks before and after PTH-ANC synthesis. Fourier transform infrared spectroscopy demonstrated no detectable interactions between micron-sized aragonite and surfactant at molecular level. PTH-ANC formulation was stabilized at pH 7.5, enabling sustained slow release of PTH 1-34 for 168 h (1 week). A 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide

cytocompatibility assay in Human Foetal Osteoblast Cell Line hFOB 1.19 showed that ANC can safely support osteoblast proliferation up to 48 h whereas PTH-ANC can safely support the proliferation at 72 h and beyond due to the sustained slow release of PTH 1-34. It was concluded that due to its biogenic nature, ANC is a cytocompatible antiosteoporotic agent. It doubles as a nanocarrier for the enhancement of efficacy and safety of the bone anabolic PTH 1-34. ANC is expected to reduce the cost, dosage, and dose frequency associated with the use of PTH 1-34 management of primary and secondary forms of osteoporosis.

Keywords: bone, FESEM, FT-IR, MTT viability, PTH 1-34, sustained release, TEM, XRD, zeta potential