Nanoformulation of core-shell type hydroxyapatite-coated gum acacia towards the biomedical applications of enhanced bioactivity and controlled drug delivery

ABSTRACT

In this work, nanospherical hydroxyapatite (HAP) was prepared that has combined properties of controlled drug delivery, biocompatibility, and antibacterial activity to have applications in the biomedical sector. The composite was formed by the sintering of HAP in the presence of Gum acacia (GA) as an emulsifier (at 600 °C) and the composite's physical properties like nucleation, size, shape, crystallinity, and surface area were characterized using spectroscopic, electron microscopic and BET (Brunauer, Emmett and Teller) studies. Typical results of the FTIR study revealed the presence of characteristic phosphate and carbonate groups of HAP and XRD provided the mean crystallite size of GA-HAP in the range of 20–50 nm. The electron micrograph of GA-HAP showed nanorods with a smooth surface interspersed in GA with particle size <50 nm and a change of shape to spheres upon increasing the concentration of GA. The presence of C, O, Ca, and P confirmed through XPS was attributed to the major elemental composition of GA-HAP. Besides, BET studies indicated that the % of GA incorporated seemed to be greatly influenced by the porosity and surface area and this particular property determined the drug loading and leaching efficacy from the GA-HAP matrices when used for drug delivery applications. After bioactivity and leaching studies in the presence of SBF (simulated body fluid), we found that the increased concentration of GA (from 1% to 10%) caused a slowdown and sustained release/burst of the naringenin drug (43% over a 72 h period). Further, antibacterial studies using the clinical strains of bacteria proved that GA-HAP/N (drug-loaded GA-HAP) possessed excellent activity toward S. aureus and E. coli with inhibition zones of 26 mm and 32 mm, respectively. Besides, the biocompatibility and cytotoxicity of GA-HAP/N showed about 90% viability for McCoy cells with no sign of detachment after 72 h of treatment, while Saos-2 cells showed typical inhibition in growth associated with rounding off and detachment, signifying cytotoxicity. This selective toxicity induced by the drug-loaded GA-HAP might find application in drug delivery for precision medicine.