The effects of pH on mineralization of bulk alginate hydrogels containing nanoparticles

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Bone tissue defects affect millions of people worldwide, and with the increasing population, there is a rising demand for materials resembling bone. One of the promising approaches to promote bone growth and healing is the development of innovative bone-mimicking materials.[1] For this purpose, our research utilized alginate hydrogels, given their ability to mimic the extracellular matrix. To further improve their properties, the alginate hydrogels were biomimetically mineralized with calcium phosphates as described in our previous work.[2] The aim of this research was to optimize the conditions for preparing both non-mineralized and mineralized alginate hydrogels with incorporated nanoparticles such as silver, copper oxide and zinc oxide. The addition of nanoparticles was intended to minimize the risk of bacterial infection, and their incorporation into the matrices addressed potential cytotoxicity risks.[3] Mineralization of the hydrogels was carried out at a pH 7.4 or 9, with the phosphate component added to the alginate and calcium being the crosslinking agent . Characterization methods included weight loss measurements, powder X-ray diffraction (PXRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and inductively coupled plasma mass spectrometry (ICP-MS). The results showed that loss of mass and overall stability clearly differed with the pH, with particularly evident mass loss for mineralized hydrogels at pH 9. Formation of calcium phosphates was also dependent on pH, having the calcium deficient hydroxyapatite formed in hydrogels at pH 7.4, and amorphous calcium phosphate in hydrogels at pH 9. The release of Cu^{2+} and Zn^{2+} was considerably higher from non-mineralized hydrogels compared to mineralized ones implying that mineralization could prevent burst release of metallic ions. Overall, these results indicate the promising potential of biomimetic mineralization of alginate hydrogels and their utilization as controlled release systems, which is of potential interest for bone-tissue engineering.

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