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MS3 – e-P9: Engineering biomimetic nano-Apatites as smart nanofertilizers: Chemical and crystallographic characterization.

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In agriculture the increase of crop yield is obtained by the application of inefficient and pollutant fertilizing techniques, using highly soluble N- and P-rich compounds. Macronutrients are inefficiently delivered to the plants root system as most of them are leached away by rainwater, causing the eutrophication of water bodies; at the same time, this highlights the wasteful exploitation of non-renewable sources as phosphate ores. A more efficient and sustainable approach to fertilization methods is required, considering the significant increase of food demand expected in the foreseeable future. To this aim, nanotechnology can offer a great contribution [1].
We synthetized hydroxyapatite-based nanocomposites [2] (a mixture of amorphous – ACP – and nanocrystalline components) doped with N-rich compounds. Characterization through routinely performed analyses such as elemental analysis, FTIR spectroscopy and XRPD were coupled to synchrotron-based Wide Angle X-ray Total Scattering (WAXTS), Small Angle X-ray Scattering (SAXS) and Static and Dynamic Light Scattering (SLS/DLS) techniques. Advanced modelling techniques based on the Debye scattering equation [3] were applied to diffraction data to characterize the nanocomposites in terms of crystallinity degree, and the crystalline fraction in terms of crystal structure, strain, size, morphology and composition of nanoapatites. Additional information on the size and morphology of the nanocomposites were obtained by SAXS analysis. The stability and nutrient release kinetics of these materials were investigated through ionselective electrodes. Results point to platy-shaped crystallites controlled by maturation time and doping. N-based ions are either incorporated in the lattice or adsorbed at the surface, showing different release kinetics. Modulating the size, structure and composition of nanoparticles is possible to provide a slow and controlled release of macronutrients by their progressive dissolution. These are promising results for the future application of nanoapatites as smart and sustainable fertilizers.

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