Bones as a source of calcium phosphates nanoparticles: towards a circular economy of smart phosphorous fertilizer

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The extensive mining of phosphate rocks and the largescale use of phosphates for agricultural purposes have depleted many of its natural supplies. A conservative analysis based on estimated phosphorous content in remaining world phosphate rock reserves and cumulative production between 1900 and 2007 based on the International Fertilizer Association data, suggested that the peak in global phosphorus production could occur by 2033.

The use of food residues as low-cost raw material could represent an attractive alternative source of phosphorous for the production of valuable agricultural compounds. In this respect, it is possible to extract calcium phosphate (CaP) nanoparticles from bones by employing a green and easily scalable process, thus complying with the principles of circular economy.

Recently, CaP nanoparticles have been advocated as promising P nanofertilizers as their soil application for soybean (*Glycine max*) cultivation gave better results with respect to commercial P fertilizer in terms of growth rate and seed yield.

The ability of CaP nanomaterials to deliver molecules and nutrients to plants together with their renown biocompatibility and bioactivity, qualify them as one of the best answers to the quests for more efficient, biologically safe and environmentally friendly nanofertilizers.

Finally, the possibility to produce CaP nanoparticles by recycling food wastes could be a fundamental step towards the development of a circular economy of phosphorous, thus enlarging the pool of resources from which P fertilizers are produced with an alternative and renewable one.