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Biopolymer Nanoparticles Loaded with Calcium as a Source of Fertilizer

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Abstract : Some nanomaterials may improve the vegetal growth in certain concentration intervals, and could be used as nanofertilizers in order to increase crops yield, and decreasing the environmental pollution due to non-controlled use of conventional fertilizers, therefore the present investigation's objective was to synthetize and characterize gelatin nanoparticles loaded with calcium generated through pulverization technique and be used as nanofertilizers. To obtain these materials, a fractional factorial design 27-4 was used in order to evaluate the largest number of factors (concentration of Ca2+, temperature and agitation time of the solution and calcium concentration, drying temperature, and % spray) with a possible effect on the size, distribution and morphology of nanoparticles. For the formation of nanoparticles, a Nano Spray-Dryer B - 90® (Buchi, Flawil, Switzerland), equipped with a spray cap of 4 µm was used. Size and morphology of the obtained nanoparticles were evaluated using a scanning electron microscope (JOEL JSM-6390LV model; Tokyo, Japan) equipped with an energy dispersive x-ray X (EDS) detector. The total quantification of Ca2+ as well as its release by the nanoparticles was carried out in an equipment of induction atomic emission spectroscopy coupled plasma (ICP-ES 725, Agilent, Mulgrave, Australia). Of the seven factors evaluated, only the concentration of fertilizer, % spray and concentration of polymer presented a statistically significant effect on particle size. Micrographs of SEM from six of the eight conditions evaluated in this research showed particles separated and with a good degree of sphericity, while in the other two particles had amorphous morphology and aggregation. In all treatments, most of the particles showed smooth surfaces. The average size of smallest particle obtained was 492 nm, while EDS results showed an even distribution of Ca2+ in the polymer matrix. The largest concentration of Ca2+ in ICP was 10.5%, which agrees with the theoretical value calculated, while the release kinetics showed an upward trend within 24 h. Using the technique employed in this research, it was possible to obtain nanoparticles loaded with calcium, of good size, sphericity and with release controlled properties. The characteristics of nanoparticles resulted from manipulation of the conditions of synthesis which allow control of the size and shape of the particles, and provides the means to adapt the properties of the materials to an specific application.

Keywords : calcium, controlled release, gelatin, nano spraydryer, nanofertilizer
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