Synthesis of Calcium Phosphate Nanoparticles in Collagen Medium

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The bone matrix that composes bone tissue may be considered a true composite, composed of interconnected calcium phosphate nanoparticles (c.a 70% m/m), originated in the mineralization of a proteic matrix composed mostly of collagen [1, 2].

Mineralization of the proteic matrix is controlled by specific interactions of ions Ca$^{+2}$ and PO$_4^{3-}$, present in the biological fluid, with the matrix, and by the diffusion of these ions. The specific interactions and the diffusion of ions combined result in the nucleation and formation of calcium phosphate particles. Moreover, they control the morphology, size, crystallinity and composition of the particles [1].

In this work, precipitation of calcium phosphate particles in a collagen matrix type I was carried out through impregnation of the matrix with a Ca$^{+2}$ and PO$_4^{3-}$ solution, with Ca/P ratio 1.67 and pH 2.5. Precipitation of particles associated with matrix structuring was carried out by adsorption of gaseous NH$_3$.

Figure 1 presents Scanning Electron Microscopy results. The micrograph shows that the precipitated particles are included in the matrix and have size around 100nm.

The X-ray diffractogram (Figure 2) shows broad peaks that indicate that the calcium phosphate is formed from small-size crystallites. Application of the Debye-Scherrer equation to the peak at 25.8° 2θ (plane 002) results in a mean crystallite size of 20nm, similar in size to the crystals that constitute bone mineral (Table 1), demonstrating that the particles formed are actually agglomerates of yet smaller particles.

<table>
<thead>
<tr>
<th>Material</th>
<th>Size (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Calcium Phosphate</td>
<td>20 nm</td>
</tr>
<tr>
<td>Bone mineral</td>
<td>20 nm</td>
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</tbody>
</table>

Figure 2: X-ray diffractograms of calcium phosphate precipitated in collagen and bone mineral.

Keywords: calcium phosphate, bioceramics, collagen, nanoparticles, synthesis.