Biomimetic Transformations of Calcium Phosphates - Thermodynamic and Kinetic Studies

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The biomimetic synthesis of XRD amorphous calcium phosphate (ACP) and dicalcium phosphate dihydrate (DCPD) and their further phase transformations into poorly crystalline apatite in three types Simulated Body Fluids (conventional (SBFc), revised (SBFr) and modified with glycine (SBFcg)) were studied by application of chemical, kinetic and spectral (XRD and IR) methods and thermodynamic simulations.

Several regularities were found:

(i) Kinetic reasons determine the biomimetic precipitation of XRD amorphous calcium phosphate (ACP) and dicalcium phosphate dihydrate (DCPD) that are a less thermodynamic stable phases in comparison with calcium hydroxyapatite;

(ii) The precipitated salts always contain impurities due to the parallel co-precipitation, ion substitution and maternal liquor incorporation. Their content depends on the nature and crystallinity of the precipitants;

(iii) Both ACP and DCPD transform into poorly crystalline apatite in the studied SBFs microenvironments. An intermediate phase of octacalcium phosphate (OCP) was registered for DCPD only.

(iv) The SBF composition influences the polymorphous phase transformation and its rate - HCO_3^- ions accelerate the transformation rates both of ACP and DCPD while the Glycine increases the transformation rate of ACP only.

(v) The phase transformations of ACP and DCPD leaded to changes in the chemical compositions of solid and liquid phases. Thermodynamic simulations reveal that these phenomena could be explained by the processes of dissolution/crystallization/co-crystallization/ion-exchange.

These results elucidate some elementary processes of hard tissue mineralization and of the influence of micro-environmental surroundings on the transformation process.

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