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Metal-substituted calcium hydroxyapatite: synthesis and application in the production of cosmetic products

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calcium hydroxyapatite, metal-substitution effects, cosmetic products, antibacterial properties

Calcium hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$, CHA) is a biocompatible and biodegradable substance with great promise for bone regeneration. Besides, CHA has attracted attention due to the possibility of using it in the development of new cosmetic products. Metal-substituted CHA is showing antibacterial properties. In addition to showing antibacterial properties, metal-substituted CHA can function as an ultraviolet (UV)-protecting agent in cosmetics.

In this study, freshly precipitated metal-substituted α-tricalcium phosphate (α-TCP) was used as a precursor for the synthesis of zinc-, copper-, or iron-substituted CHA samples under hydrothermal conditions. The amount of the transition metal ions in the samples corresponded to the Ca substitution level of 0.8 – 1 mol%. The synthesis procedure could be briefly described as follows: 0.3 g of metal-substituted α-TCP powders were placed in 90 mL vessels to which 20 mL of water were added. The sealed vessels were placed in an oven heated up to 200 °C. After the initial heating for 30 min (to reach the treatment temperature), the hydrothermal treatment was applied for 16 h. Subsequently, the vessels were cooled down to room temperature and the samples were filtered, washed with ethanol and acetone, and dried at 50 °C overnight.

Powder X-ray diffraction data for synthesized samples were collected using a Rigaku MiniFlex II diffractometer that emitted Ni-filtered Cu Kα radiation and worked in Bragg-Brentano (θ/2θ) geometry. Infrared spectra in the range of 4000−400 cm^{-1} were recorded using a Bruker ALPHA ATR spectrometer, while the sample morphology was determined using a Hitachi SU-70 field-emission scanning electron microscope (FE-SEM). Samples were prepared for elemental analysis by dissolving them in 5% nitric acid and diluting the solution with deionized water. Analysis was performed on Perkin Elmer Optima 7000 DV ICP-OES system.

The production of a cosmetic product consisted of three stages: (a) preparation of the oil phase; (b) preparation of the aqueous phase; and (c) connecting temperature-sensitive components. The oil phase was melted in a separate beaker with slow stirring and heating of the