

Characterization of Hydroxyapatite Derived from Sri Lankan Rock Phosphate for Biomedical Applications

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Hydroxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$, (HA) is an important inorganic biomaterial with a structural similarity to minerals of human bone and teeth. HA is widely used for repairing bone defects in dental and orthopedic sites as filler or as a coating to promote bone ingrowth into prosthetic implants. Rock phosphate deposit at Eppawela Sri Lanka provides a rich source of chlorofluoroapatite which could be converted to HA. Conversion of apatite into hydroxyapatite was done by mixing 19.9 g of calcium hydroxide with 250 g of apatite powder (3:1 ratio) with constant stirring to achieve a homogeneous mixture, followed by high temperature sintering at 1000°C for 3 hours. Sintered HA was subjected to physical and chemical analysis to confirm successful conversion of apatite to HA and to establish its suitability in biomedical applications. Test conditions used were similar to pH and temperature changes that may occur in oral cavity of humans. FTIR spectroscopy patterns confirmed the formation of a hydroxyl group to crystalline phase of HA. FTIR spectra showed a stretching bond at 3420 cm^{-1} which indicates the presence of HA. Peaks at 1030 to 1085 cm^{-1} corresponds to symmetric stretching mode of PO_4^{3-} while peak at 564 cm^{-1} indicates the bending mode of NV^- . The large separation bands indicate the presence of crystalline phase. Solubility (% weight loss) was high in pH 4 for all three temperatures tested (55°C, 30°C and 5°C) indicating acidulation of HA at low pH. At higher pH, solubility was insignificant. The % weight loss correlates with the amount of Ca^{2+} and PO_4^{3-} ions dissolved in the solution. The calculated thermal expansion coefficient of HA was $17.436 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$ which is x3 higher than that of human teeth (i.e. $6.603 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$). Compressive strength of synthesized HA pellets was between 19-23 MPa which is lower than the expected value of 100 MPa of natural bones. Conversion method adapted in this study is simple and easy compared to popular Sol-gel method. Synthesized HA was stable at high pH between 5°C to 55°C. Lower compressive strength and high thermal expansion coefficient obtained with synthesized HA suggests that the conversion method needs optimization to make the product suitable for biomedical applications.

Keywords: Rock Phosphate; Hydroxyapatite; High temperature sintering, Biomedical applications