

Structural study of porcine Bio-hydroxyapatite obtained by young and adult mammals raised on a farm

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Nowadays, hydroxyapatite (HAp) is a biomaterial used to guided bone regeneration [1], being important to have a knowledge of crystalline structure when the bioceramic is obtained by different sources. HAp could be synthesized or extracted from mammals (Bio-hydroxyapatite) [1]. The most used Bio-hydroxyapatite (Bio-HAp) is obtained from porcine and bovine [1]. The structure of biogenic HAp has been analysed without specification on the diet, age, or race of the animal, which generates problems on its use [1 - 5]. The diet changes minerals on the bones, Ca/P, Ca/Mg ratios, and the age is related to the bone mineral density (BMD) [1, 6]. On the other hand, the bilateral symmetry and sagittal plane on the mammals affects the size of the bones [7]. This work focuses on the structural study of young and adult porcine Bio-HAp samples with a suitable strict diet for use in human consumption and similar femur size for discarding dominant side contributions given by the sagittal plane. Bioceramics were extracted by a hydrothermal process [8] to obtain the inorganic phase (crystalline). The samples were calcinated at different temperatures to a void micro strength on the matrix. It obtained the crystalline structure, Ca/P, and Ca/Mg ratios of the powder samples. According to Scanning Electron Microscopy the organic phase has been removed and the samples have not micro strength. Atomic Absorption Spectroscopy and Inductively coupled plasma mass spectrometry indicates that the ratios changes depending on the age of the mammal. Study by X-Ray Diffraction using Rietveld refinement shows the structure of the samples, crystalline quality and the mean size of the crystallite for each mammal. Euler configuration indicates the micro strength on the crystal. Vesta software was used to represent the unit cell. Finally, these analyses help to know that the different parameters of the mammal care and dominant side are important because of affecting the crystalline structure.

- [1] Castillo-Paz, A.M., Correa-Piña, B.A., Martínez-Hernandez, H.D., Gomez-Vazquez, O.M., Cañon-Davila, D.F., Zubieta-Otero, L.F., Londoño-Restrepo, S.M., Perez-Torrero, E. & Rodriguez-Garcia, M.E. (2022). *Biomedical Materials & Devices*, pp. 1-17.
- [2] Stork, L., Müller, P., Dronskowski, R., & Ortlepp, J. R. (2005). *Zeitschrift für Kristallographie-Crystalline Materials*, **220**, 201-205.
- [3] Chakraborty, S., Bag, S., Pal, S., & Mukherjee, A. K. (2006). *Journal of Applied Crystallography*, **39**, 385-390.
- [4] Querido, W., Abraçado, L. G., Rossi, A. L., Campos, A. P. C., Rossi, A. M., San Gil, R. A. S., Borojevic, R., Balduino, A. & Farina, M. (2011). *Calcified Tissue International*, **89**, 358-371.
- [5] Mugnaioli, E., Reyes-Gasga, J., Kolb, U., Hemmerlé, J., & Brès, É. F. (2014). *Chemistry—A European Journal*, **20**, 6849-6852.
- [6] Wang, S., Zhang, P., Kong, X., Xie, S., Li, Q., Li, Z., & Zhou, Z. (2017). *Animal Science Journal*, **88**, 1820-1826.
- [7] Mészáros, S., Ferencz, V., Csupor, E., Mester, Á., Hosszú, É., Tóth, E., & Horváth, C. (2006). *European journal of radiology*, **60**, 293-298.
- [8] Ramirez-Gutierrez, C. F., Londoño-Restrepo, S. M., Del Real, A., Mondragón, M. A., & Rodriguez-García, M. E. (2017). *Ceramics International*, **43**, 7552-7559.

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