World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:11, No:11, 2017

Collagen/Hydroxyapatite Compositions Doped with Transitional Metals for Bone Tissue Engineering Applications

Authors : D. Ficai, A. Ficai, D. Gudovan, I. A. Gudovan, I. Ardelean, R. Trusca, E. Andronescu, V. Mitran, A. Cimpean

Abstract : In the last years, scientists struggled hardly to mimic bone structures to develop implants and biostructures which present higher biocompatibility and reduced rejection rate. One way to obtain this goal is to use similar materials as that of bone, namely collagen/hydroxyapatite composite materials. However, it is very important to tailor both compositions but also the microstructure of the bone that would ensure both the optimal osteointegartion and the mechanical properties required by the application. In this study, new collagen/hydroxyapatites composite materials doped with Cu, Li, Mn, Zn were successfully prepared. The synthesis method is described below: weight the $Ca(OH)_2$ mass, i.e., 7,3067g, and $ZnCl_2$ (0.134g), $CuSO_4$ (0.159g), $LiCO_3$ (0.133g), $MnCl_2.4H_2O$ (0.1971g), and suspend in 100ml distilled water under magnetic stirring. The solution thus obtained is added a solution of NaH_2PO_4*H2O (8.247g dissolved in 50ml distilled water) under slow dropping of 1 ml/min followed by adjusting the pH to 9.5 with HCl and finally filter and wash until neutral pH. The as-obtained slurry was dried in the oven at 80°C and then calcined at 600°C in order to ensure a proper purification of the final product of organic phases, also inducing a proper sterilization of the mixture before insertion into the collagen matrix. The collagen/hydroxyapatite composite materials are tailored from morphological point of view to optimize their biocompatibility and bio-integration against mechanical properties whereas the addition of the dopants is aimed to improve the biological activity of the samples. The addition of transitional metals can improve the biocompatibility and especially the osteoblasts adhesion (Mn^{2+}) or to induce slightly better osteoblast differentiation of the osteoblast, Zn^{2+} being a cofactor for many enzymes including those responsible for cell differentiation. If the amount is too high, the final material can become toxic and lose all of its biocompatibility. In order to achieve a good biocompatibility and not reach the cytotoxic effect, the amount of transitional metals added has to be maintained at low levels (0.5% molar). The amount of transitional metals entering into the elemental cell of HA will be verified using inductively-coupled plasma mass spectrometric system. This highly sensitive technique is necessary, because, at such low levels of transitional metals, the difference between biocompatible and cytotoxic is a very thin line, thus requiring proper and thorough investigation using a precise technique. In order to determine the structure and morphology of the obtained composite materials, IR spectroscopy, X-Ray diffraction (XRD), scanning electron microscopy (SEM), and Energy Dispersive X-Ray Spectrometry (EDS) were used. Acknowledgment: The present work was possible due to the EU-funding grant POSCCE-A2O2.2.1-2013-1, Project No. 638/12.03.2014, code SMIS-CSNR 48652. The financial contribution received from the national project “Biomimetic porous structures obtained by 3D printing developed for bone tissue engineering (BIOGRAFTPRINT), No. 127PED/2017 is also highly acknowledged.

Keywords : collagen, composite materials, hydroxyapatite, bone tissue engineering
Conference Title : ICEBB 2017 : International Conference on Environmental, Biomedical and Biotechnology
Conference Location : Venice, Italy
Conference Dates : November 13-14, 2017