In-Vitro Testing of a Novel Bacterial Cellulose-Hydroxyapatite Biomaterial

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Bacterial cellulose is a biopolymer that is currently being investigated for use in a variety of biomedical applications. Its highly crystalline structure consists of a network of minute cellulose fibrils laid down in layers by the bacteria. Inter- and intra-fibrillar hydrogen bonding grants this polymer high mechanical strength and hydrophilicity. Reported biomedical uses include a bacterial cellulose skin substitute that is currently in clinical use; as well as replacement of blood vessels, gingiva, and the dura mater during in-vivo animal testing. Bacterial cellulose is a suitable matrix for the nucleation and deposition of bioceramics. Its hydrophilicity enables particulates to infiltrate its network. The presence of hydroxyl and aldehyde groups initiates and modulates particulate formation. Calcium phosphate particles were precipitated in bacterial cellulose by consecutive incubations in aqueous calcium chloride followed by sodium phosphate at physiological pH and temperature. X-ray diffraction confirmed that this precipitate was calcium-deficient hydroxyapatite, the main mineral component of bone. This contrasts other hydroxyapatite synthesis methods that may use harsh chemicals (e.g. orthophosphoric acid) at extreme temperature or pressure conditions (hydrothermal reactions at 275ºC / 12000 psi). It is hoped that this composite may be used as a biomaterial in orthopedic applications. Osteoblasts were used for the in-vitro evaluation of the compatibility of the calcium-deficient hydroxyapatite-bacterial cellulose matrix. The adhesion of bone cells to an implant indicates that a solid fusion between the material and the bone tissue is possible. Thus the material may be used as a therapeutic implant to regenerate bone and heal osseous damage. Osteoblasts were cultured onto bacterial cellulose substrates synthesized under varying culture conditions, and also on the hydroxyapatite bacterial cellulose in comparison with native bacterial cellulose. By performing cell counts and alkaline phosphatase assays, it was proven that the osteoblasts preferentially attached to the hydroxyapatite bacterial cellulose versus native bacterial cellulose.

*Research sponsored by the Division of Chemical Sciences, Geosciences, and Biosciences, Office of Basic Energy Sciences, U.S. Department of Energy, under contract No. DE-AC05-00OR22725, with Oak Ridge National Laboratory, managed and operated by UT-Battelle, LLC.