Degradation, bioactivity and cytotoxicity evaluation of Polyhydroxyalkanoate (PHA) reinforced with nano-calcium phosphate (nCaP) and chitosan for bone regeneration.

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Abstract:

Polyhydroxyalkanoates (PHA) exhibit tremendous potential for bone tissue regeneration, owing to their biocompatibility and biodegradability. To address limitations in supporting bone growth, researchers have employed a strategic approach of reinforcing PHA with calcium phosphate (CaP), leading to transformative advancements. This comprehensive study investigates the bioactivity properties of composites prepared using biodegradable PHA reinforced with nano-CaP and chitosan (CH), which serve as natural carriers for growth factors and demonstrate antimicrobial properties. Various in vitro methods, including Tris-HCL degradation, simulated body fluids (SBF), and cytotoxicity tests, were employed to evaluate the performance of the composites. PHA served as the matrix, while nano-CaP (3-15wt%) was incorporated as a reinforcement along with a constant 10wt% of CH. The results revealed slower and steady degradation rates for both PHA and PHA/n-CaP/CH composites, as evidenced by water uptake and mass change profiles. SBF testing, confirmed by scanning electron microscopy-energy-dispersive X-ray spectroscopy (SEM-EDX) analysis, demonstrated the formation of an apatite layer on the composites' surface within three days, indicating excellent bioactivity potential of nano-CaP. Furthermore, the sustained apatite layer formation after 28 days strongly indicated the composites' effectiveness in promoting bone integration in vivo. Moreover, the composites maintained a neutral pH of Tris-HCl degradation and SBF media, closely resembling the physiological environment (pH 7.40). Cytotoxicity evaluations using the Alamar Blue assay confirmed the non-toxicity of the composites to osteoblast cells, accompanied by enhanced cell proliferation and viabilities exceeding 100%. Additionally, the osteogenic differentiation of human fetal osteoblasts assessed via alkaline phosphatase activity testing further emphasized the potential of PHA and PHA/n-CaP/CH composites as promising materials for bone regeneration applications. Collectively, these findings highlight the remarkable prospects of PHA-based composites in advancing bone tissue engineering and regeneration therapies.

What will audience learn from your presentation?

(Try to list 3-5 specific items)

1. The research investigates the bioactivity properties of PHA and PHA/n-CaP/CH composites, shedding light on their potential for applications in tissue engineering and regenerative medicine.
2. The water uptake and mass change profiles of the composites provide insights into their degradation behavior and potential for use as scaffolds in biomedical applications.
3. The pH values of the degradation media demonstrate the stability of the composites in a physiological environment, further supporting their potential as biomaterials.
4. The formation of apatite layers on the composites' surfaces indicates their excellent bioactivity capabilities, which is crucial for promoting bone regeneration and integration.
5. The calcium-to-phosphate ratio in the formed apatite layer resembles that of natural bone, highlighting the biomimetic properties of the composites and their potential to support bone tissue growth and healing.

Biography of presenting author (should not exceed 100 words)

Constance Gnanasagaran is a Chartered Engineer and Lecturer in Mechanical Engineering at Kingston University London. Her research focuses on Tissue Engineering, Biomaterials, and Additive Manufacturing, with interests in sustainability, life cycle assessments, and computational biology. Her work in tissue engineering scaffolds and advanced composites holds promise for regenerative medicine and orthopedic implants. With dedication to innovation and interdisciplinary collaboration, she aims to drive advancements, developing novel biomaterials for clinical practice. Gnanasagaran strives to contribute at the intersection of engineering and healthcare, addressing challenges and improving patient outcomes through research endeavors.

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