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Preparation and characterization of polyhydroxyalkanoates macroporous scaffold through enzyme-mediated modifications (Article)

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Abstract

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Polyhydroxyalkanoates (PHAs) are hydrophobic biodegradable thermoplastics that have received considerable attention in biomedical applications due to their biocompatibility, mechanical properties, and biodegradability. In this study, the degradation rate was regulated by optimizing the interaction of parameters that influence the enzymatic degradation of P(3HB) film using response surface methodology (RSM). The RSM model was experimentally validated yielding a maximum 21 % weight loss, which represents onefold increment in percentage weight loss in comparison with the conventional method. By using the optimized condition, the enzymatic degradation by an extracellular PHA depolymerase from Acidovorax sp. DP5 was studied at 37 C and pH 9.0 on different types of PHA films with various monomer compositions. Surface modification of scaffold was employed using enzymatic technique to create highly porous scaffold with a large surface to volume ratio, which makes them attractive as potential tissue scaffold in biomedical field. Scanning electron microscopy revealed that the surface of salt-leached films was more porous compared with the solvent-cast films, and hence, increased the degradation rate of salt-leached films. Apparently, enzymatic degradation behaviors of PHA films were determined by several factors such as monomer composition, crystallinity, molecular weight, porosity, and roughness of the surface. The hydrophilicity and water uptake of degraded salt-leached film of P(3HB-co-70%4HB) were enhanced by incorporating chitosan or alginate. Salt-leached technique followed by partial enzymatic degradation would enhance the cell attachment and suitable for biomedical as a scaffold. © 2013 Springer Science+Business Media New York.

Author keywords

Enzymatic degradation | Experimental design | PHA depolymerase | Polyhydroxyalkanoates | Surface modification

Indexed keywords

Compendex keywords: Biodegradable thermoplastics | Biomedical applications | Conventional methods | Depolymerase | Enzymatic Degradation | Monomer compositions | Polyhydroxyalkanoates | Response surface methodology

Engineering controlled terms: Biocompatibility | Biodegradation | Biomechanics | Copolymerization | Degradation | Design of experiments | Leaching | Mechanical properties | Medical applications | Optimization | Scanning electron microscopy | Surface treatment | Tissue

Engineering main heading: Scaffolds (biology)

EMTREE drug terms: polyhydroxyalkanoic acid | tissue scaffold

EMTREE medical terms: Acidovorax, article, biodegradability, cell adhesion, comparative study, controlled study, enzymatic degradation, enzyme active site, enzyme activity, enzyme modification, film, hydrolysis, hydrophilicity, incubation time, molecular weight, nonhuman, pH, porosity, reaction time, response surface method, scanning electron microscopy, water transport, weight reduction

MeSH: Biodegradation, Environmental, Carboxylic Ester Hydrolases, Hydrophobic and Hydrophilic Interactions, Hydroxybutyrates, Microscopy, Electron, Scanning, Molecular Weight, Polyesters, Polyhydroxyalkanoates, Spectroscopy, Fourier Transform Infrared, Tissue Scaffolds

Species Index: Acidovorax

Chemicals and CAS Registry Numbers:

Carboxylic Ester Hydrolases, 3.1.1.-; Hydroxybutyrates; Polyesters; Polyhydroxyalkanoates; poly(3-hydroxyalkanoic acid) depolymerase, 3.1.1.-

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