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

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Abstract

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 one fold 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. DPS 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.
References (37)

VCH New York

M. Chiao & J. C. Chiao (Eds) Pan Stanford Publishing Book

Abe, H., Doi, Y., Aoki, H., Akehata, T.
Solid-state structures and enzymatic degradabilities for melt-crystallized films of copolymers of (R)-3-hydroxybutyric acid with different hydroxyalkanoic acids
View at Publisher

Renard, E., Walls, M., Guérin, P., Langlois, V.
Hydrolytic degradation of blends of polyhydroxyalkanoates and functionalized polyhydroxyalkanoates
View at Publisher

Hiraishi, T., Taguchi, S.
Enzyme-catalyzed synthesis and degradation of biopolymers
http://www.ingentaconnect.com/content/ben/mroc/2009/00000006/00000001/art00005
doi: 10.2174/157019309787316139
View at Publisher

View at Publisher


View at Publisher


View at Publisher


View at Publisher


View at Publisher


View at Publisher


View at Publisher
Heterogeneous kinetics of the enzymatic degradation of poly(β-hydroxyalkanoates)  
http://www.journals.elsevier.com/polymer/  
doi: 10.1016/S0032-3861(96)00530-7  
View at Publisher

Biodegradation of biosynthetic and chemosynthetic polyhydroxyalkanoates  
Y. Doi & K. Fukuda (Eds) Amsterdam: Elsevier Science B.V

Kinetics of surface hydrolysis of poly[(R)-3-hydroxybutyrate] film by PHB depolymerase from Alcaligenes faecalis T1  
doi: 10.1016/0141-3910(95)00026-I  
View at Publisher

Synthesis, structure and properties of polyhydroxyalkanoates: Biological polyesters  
doi: 10.1016/S0079-6700(00)00035-6  
View at Publisher

Purification and properties of a poly (β-hydroxybutyrate) depolymerase from Penicillium sp.  
doi: 10.1007/s10924-006-0031-6  
View at Publisher

Characterization of a poly(3-hydroxybutyrate) depolymerase from Aureobacterium saperdae: Active site and kinetics of hydrolysis studies  

Structure and enzymatic degradation of poly(3-hydroxybutyrate) copolymer single crystals with an extracellular PHB depolymerase from Alcaligenes faecalis T1  
doi: 10.1016/S0141-8130(99)00031-8  
View at Publisher
Structural effects on enzymatic degradabilities for poly[(R)-3-hydroxybutyric acid] and its copolymers

doi: 10.1016/S0141-8130(99)00033-1

View at Publisher

Conversion of woody biomass into fermentable sugars by cellulase from *Agaricus arvensis*

doi: 10.1016/j.biortech.2010.06.055

View at Publisher

Biodegradability of poly(hydroxyalkanoate) materials

doi: 10.3390/ma2031104

View at Publisher

Biodegradation studies of poly(3-hydroxybutyrate-co-3-hydroxyhexanoate)

doi: 10.1016/j.polymdegradstab.2004.02.010

View at Publisher

Polyhydroxyalkanoates: Biodegradable polymers with a range of applications

doi: 10.1002/jctb.1667

View at Publisher

Microbial synthesis and properties of poly(3-hydroxybutyrate-co-4-hydroxybutyrate)


View at Publisher

Degradation of microbial polyesters

doi: 10.1023/B:BILE.0000036599.15302.e5

View at Publisher

Study of enzymatic degradation of microbial copolymers consisting of 3-hydroxybutyrate and medium-chain-length 3-hydroxyalkanoates

doi: 10.1016/j.polymdegradstab.2007.06.001

View at Publisher