Enhanced production of poly (3-hydroxybutyrate-co-4-hydroxybutyrate) copolymer with manipulated variables and its properties

Abstract

Cupriavidus sp. USMAA1020, a local isolate was able to biosynthesis poly(3-hydroxybutyrate-co-4-hydroxybutyrate) [P(3HB-co-4HB)] copolymer with various 4HB precursors as the sole carbon source. Manipulation of the culture conditions such as cell concentration, phosphate ratio and culture aeration significantly affected the synthesis of P(3HB-co-4HB) copolymer and 4HB composition. P(3HB-co-4HB) copolymer with 4HB compositions ranging from 23 to 75 mol% 4HB with various mechanical and thermal properties were successfully produced by varying the medium aeration. The physical and mechanical properties of P(3HB-co-4HB) copolymers were characterized by NMR spectroscopy, gel-permeation chromatography, tensile test, and differential scanning calorimetry. The number-average molecular weights (M (n)) of copolymers ranged from 260 x 10(3) to 590 x 10(3)Da, and the polydispersities (M (w)/M (n)) were between 1.8 and 3.0. Increases in the 4HB composition lowered the molecular weight of these copolymers. In addition, the increase in 4HB composition affected the randomness of copolymer, melting temperature (T (m)), glass transition temperature (T (g)), tensile strength, and elongation to break. Enzymatic degradation of P(3HB-co-4HB) films with an extracellular depolymerase from Ochrobactrum sp. DP5 showed that the degradation rate increased proportionally with time as the 4HB fraction increased from 17 to 50 mol% but were much lower with higher 4HB fraction. Degradation of P(3HB-co-4HB) films with lipase from Chromobacterium viscosum exhibited highest degradation rate at 75 mol% 4HB. The biocompatibility of P(3HB-co-4HB) copolymers were evaluated and these copolymers have been shown to support the growth and proliferation of fibroblast cells.