Abstract

Poly(3-hydroxybutyrate-*co*-3-hydroxyvalerate) [P(3HB-*co*-3HV)] co-polymer has attracted considerable interest in recent years as an eco-friendly 'green' thermoplastic to overcome the problems associated with waste plastic materials. In this study, accumulation of P(3HB-*co*-3HV) co-polymer in a filamentous N_2-fixing cyanobacterium, *Nostoc muscorum* Agardh was investigated. Under photoautotrophic growth condition, the test cyanobacterium accumulated the homopolymer of poly-*β*-hydroxybutyrate (PHB) with a maximum value of 8.6% of dry cell weight (dcw) at the stationary phase of growth. P(3HB-*co*-3HV) co-polymer synthesis was observed under propionate- and valerate-supplemented conditions, and confirmed by ^{1}H-NMR, FTIR and GC-MS analyses.

Various cultural and nutritional factors affecting biomass and P(3HB-*co*-3HV) co-polymer accumulation in *N. muscorum* Agardh were investigated. Amongst various carbon sources, the co-polymer content boosted maximum up to 50% (dcw) under 0.4% acetate + 0.4% valerate supplementation. Multifactor optimization of the above variables resulted into an accumulation of 69% (dcw) at 0.28% acetate, 0.38% glucose, and 0.3% valerate for an incubation period of 7 days. Further, under optimized condition with N-deficiency, the co-polymer content reached up to 78% (dcw), which could be comparable with the high PHA-accumulating bacterial species.

N. muscorum Agardh was cultivated in a 5 L photobioreactor with varying CO_2 concentration in the air flow. Maximum biomass and PHB yield of 1120 mg l^{-1} and 23% (dcw) respectively, were recorded with 10% CO_2-purging on day 8 of incubation. Different concentrations of poultry litter (PL) were used as supplements for cultivation of the test cyanobacterium. The nutrient removal efficiency of *N. muscorum* Agardh was reflected by significant reduction in nutrient load of the PL over the experimental period. Maximum P(3HB-*co*-3HV) co-polymer yield of 774 mg l^{-1} (65% dcw) was recorded in 10 g l^{-1} PL-supplemented vessels with 10% CO_2-purging under the optimized condition.

The material properties of the extracted PHB and P(3HB-*co*-3HV) co-polymer films were studied by mechanical tests, differential scanning calorimetry (DSC), thermogravimetric analysis (TGA) and surface analysis. The polymers exhibited comparable material properties with the commercial polymers, thus advocating their suitability for various industrial applications.

Keywords: Differential scanning calorimetry (DSC), *Nostoc muscorum* Agardh, P(3HB-*co*-3HV) co-polymer, Scanning electron microscope (SEM), Thermogravimetric analysis (TGA)