ABSTRACT

Problems associated with the conventional plastics on global environment have generated interest in the development of biodegradable plastic polymers. The search for such biodegradable plastics has led to a number of partially or completely biodegradable products such as polylactides, polyglycolic acids, aliphatic polyesters, polyhydroxyalkanoates, polysaccharides and their blends. Amongst them, the microbially-originated polyhydroxyalkanoates (PHAs) offer much potential for significant contributions as 'bioplastics'.

In this study, accumulation of PHAs in a unicellular cyanobacterium, *Synechocystis* sp. PCC 6803 was investigated. Under photoautotrophic growth condition, the test cyanobacterium was found to accumulate the homopolymer of poly-*β*-hydroxybutyrate (PHB) with a maximum value of 4.5% of dry cell weight (dcw) at the stationary phase of growth. Chemical proofs for PHB were obtained from UV-spectroscopy, FT-IR, NMR and GC-MS analyses.

Effects of various cultural and nutritional variables on PHB accumulation were studied. PHB accumulation was found to be stimulated under N- and P-deficient conditions. Chemoheterotrophy and mixotrophy under gas-exchange limitations enhanced the PHB yield up to 22 and 30%, respectively. Optimization of the process variables by response surface methodology (RSM) resulted into an accumulation of 43% (dcw), the value almost 10 fold higher as compared to the yield under photoautotrophic growth condition.

Uncouplers like CCCP and DCCD stimulated PHB accumulation, whereas supplementation of DCMU to the photoautotrophically-grown cultures suppressed PHB accumulation. The mobilization of PHB in *Synechocystis* was found to be relatively faster under illuminated and the usual light-dark cycles than under dark condition. However, mobilization of PHB was found to be greatly reduced in carbon-supplemented medium.

Synechocystis sp. PCC 6803 was also found to be capable of synthesizing P(3HB-*co*-3HV) co-polymer in presence of propionate/ valerate. The material properties of PHB and P(3HB-*co*-3HV) co-polymer produced by the test cyanobacterium was studied by mechanical tests, surface analysis, crystalline morphology, differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA), and compared with the commercially available polymers as well as with other reported literature. The co-polymer with 25 mol% of HV was found to be the best polymer in this study and could be comparable with the commercial P(3HB-*co*-3HV) co-polymer obtained from Aldrich (USA).

Keywords: Chemoheterotrophy, gas-exchange limitation, mixotrophy, mobilization, polyhydroxyalkanoates (PHAs), poly-*β*-hydroxybutyrate (PHB), P(3HB-*co*-3HV) co-polymer, response surface methodology (RSM), *Synechocystis* sp. PCC 6803