Abstract

The present study explores the prospect for producing bioethanol along with high-value co-products from cyanobacterial biomass by strategizing a refinery approach. After an initial screening of various cyanobacterial species under control growth condition in BG-11 medium, *Anabaena variabilis* was chosen for subsequent study based on its higher accumulation of total carbohydrate and fermentable sugars like reducing sugar and glycogen, among all the species.

Individual factor studies with varying nutritional and cultural conditions revealed the growth and carbohydrate accumulation of *A. variabilis* to be mostly influenced by the initial culture pH, HCO_3^-, and Mg^{2+} levels of the cultivation medium. Optimization of these factors applying the statistical technique (Response Surface Methodology) enhanced the biomass and total carbohydrate yield by a respective ~1.5-fold and ~2.4-fold, with a ~2.6-fold higher yield of reducing sugar and glycogen than the BG-11 control. Consequently, the bioethanol production was escalated by ~2.5-fold. The devised condition was also fruitful in augmenting the yield of various co-products, viz. poly-β-hydroxybutyrate, exopolysaccharides, C-phycocyanin and sodium copper chlorophyllin from the test cyanobacterium. Under the cyanobacterial refinery designed by step-wise extraction of all the co-products along with bioethanol, 75% of the cyanobacterial biomass was efficiently transformed into high-value products utilizing the optimized BG-11 medium.

To further integrate the process with waste utilization, the study also endeavored to formulate a medium combining Aqua discharge (AD) with Poultry litter (PL) or Cow dung (CD). AD supplemented with 7.5 g/L PL was found to be the most effective combination resulting into 46% higher carbohydrate yield than the BG-11 control. This medium termed as 'APL' medium also displayed a 100% removal of nitrite, nitrate, and orthophosphate, with a respective 74% and 81% removal of ammonium and total organic carbon, and 90% reduction in chemical and biological oxygen demand, when *A. variabilis* was cultivated in it. The formulated APL medium also proved suitable for the biorefinery approach, with a 13 - 21% reduction in the yield of bioethanol and the co-products compared to the optimized BG-11 medium, while simultaneously bioremediating the wastes.

Keywords: *Anabaena variabilis*; Bioethanol; Bioremediation; C-phycocyanin; Exopolysaccharides; Optimization; Poly-β-hydroxybutyrate; Sodium copper chlorophyllin; Wastes