Polyhydroxybutyrate (PHB) Production in Bacteria: A Sustainable Approach to Eco-Friendly Plastics

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Plastic pollution poses a significant environmental threat, resulting in over 29 million tons of plastic waste generated every year. With the demand for plastic increasing, it becomes imperative to find sustainable solutions to these petroleum-based pollutants. Polyhydroxybutyrate (PHB), a bioplastic produced by bacteria, holds potential as an answer to this problem, but high production costs have hindered its commercialization. This study investigates the use of inexpensive industrial by-products as alternative carbon (C) and nitrogen (N) sources to produce PHB in B. subtilis. Bacteria were initially grown in buffered LB broth, which was then altered to test various C and N sources to determine what effect they have on bacterial PHB levels. Evaluation of the PHB produced using FTIR (Fourier Transform Infrared Spectroscopy) demonstrated that the alternative C and N sources did not alter the chemical composition of the bioplastic. Using buffered LB broth, PHB was 35% of the cell mass; substituting 0.12% unsulfured molasses (w/v) for glucose increased PHB levels to 36% of cell mass; and using unsulfured molasses plus 0.5% corn steep liquor (w/v) in place of tryptone in the medium increased PHB levels to 68% of cell mass (w/w). In a cost comparison of bulk prices for ingredients, using the industrial by-products of unsulfured molasses and corn steep liquor as C and N sources compared to using glucose and tryptone, respectively, lowered the price per kg of PHB synthesized from $40 to $12. The results of this study demonstrate that sustainable bacteria-generated plastic can be produced in a cost-effective manner while maximizing yield. This is a breakthrough in combating the petrochemical plastic crisis and merits further study to optimize bioplastic production.