National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Bioprocess Development of Bacterial Polyhydroxyalkanoates: Efficient Production and Cost-effective Extraction for Potential Applications
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Venue	: Seminar Room (BM) (Hybrid)
Date and Time	: 22 Jan 2025 (08:30 AM)

Abstract : The widespread use of synthetic plastics has increased the environmental risks, emphasizing the need for eco-friendly alternatives for their replacement. Among various bioplastics, bacterial Polyhydroxyalkanoates (PHAs) have been identified as a viable replacement. In this study, 94 bacterial isolates were screened using a 3-tiered process for PHA production, and five tested positive. Among those, two strains namely, PhNs9 and PhNs10, were selected for their non-virulence. The 16S rRNA gene sequencing revealed that PhNs9 and PhNs10 were related to the Bacillus and Pseudomonas genera, respectively, and the former was selected for its superior yield. Different characterizations of the PHA produced by Bacillus sp. PhNs9 in glucose medium revealed it to be Polyhydroxybutyrate (PHB). Process optimization using response surface methodology (RSM) and the bioreactor scale production resulted in a PHA yield of 2.70 gL-1 corresponding to 71% accumulation in biomass (YP/X). The PHB also demonstrated excellent biodegradability in different environments with 99% degradation in soil in 30 days. Sugarcane molasses (SM) was selected as a cost-effective substrate due to its higher yield among screened industrial byproducts and wastes. A fed-batch process was developed and optimized using an artificial neural network (ANN) and genetic algorithm (GA) which increased the PHA yield to 3.72 gL-1 and YP/X of 0.79 gg-1 at the bioreactor scale. The produced PHA was similar to Polyhydroxybutyrate-valerate (PHBV). Techno-economic analysis of the developed process resulted in a minimum selling price of PHA as $12 kg-1 confirming its commercial viability. For PHA extraction, a novel process of electrochemical cell lysis (ECL) was developed, optimized using ANN-GA, and automatized using the principle of turbidometry. It was studied to reduce the downstreaming cost by 80.40% maintaining the characteristics of PHA. A biocomposite was prepared by blending extracted PHA, neem oil, and threadlets. It was found to be antibacterial, non-cytotoxic, and biodegradable with higher tensile strength. The different bioactive compounds like nimbin, azadirachtin, and salannin providing medicinal properties were confirmed for their presence in neem oil through high-resolution mass spectroscopy (HR-MS). The cost of prepared biomaterial was calculated to be ₹ 0.29 cm-2 , highlighting the process&rsquos economic viability in commercializing PHAs as an eco-friendly alternative to synthetic plastics, especially in the field of medicine.

Keywords: Polyhydroxyalkanoates Bacillus Sugarcane molasses Fed-batch Electrochemical cell lysis Biocomposite.