INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Bioprocess development for polyhydroxybutyrate (PHB) production from waste carob pods and its application in food packaging: A biorefinery approach

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SHORT ABSTRACT

Increasing concern on white pollution has necessitated the need for an alternate polymer possessing excellent performance. Polyhydroxybutyrate (PHB) is a highly biodegradable and sustainable polymer which is entirely sourced from microorganisms and offers tremendous potential for the green revolution. However, elevated cost incurred during its production limits its commercialization. This problem was tackled, and a cost-effective PHB production process was demonstrated by replacing various conventional techniques with emerging bioprocess technologies. A novel closed-loop biorefinery strategy was developed to utilize carob pods as the feedstock for both upstream to downstream processing of PHB. The PHB produced further resulted in a biopolymer with superior antimicrobial properties due to the intrusion of lignin-derived from the carob pods. In addition to reduction in the overall PHB production cost, achieved by using carob pods as the cheap feedstock, efforts were laid by introducing a novel wide-gap annular bioreactor for PHB fermentation and a tubular ceramic membrane assembly for its recovery. Whereas the wide-gap annular bioreactor resulted in 1.6 times higher PHB production titre than a stirred tank bioreactor, almost complete PHB recovery along with heightened throughput was attained using the novel tubular ceramic membrane assembly. By inclusion of graphene nanoplatelets to the PHB matrix, a highly durable packaging film was produced which showed a four-fold increase in shelf-life of food items like potato chips and milk product. Cost-effectiveness offered by the various novel strategies and technologies developed in the present study was further revealed by the reduced payback period and high turnover through a detailed techno-economic assessment. Thus, the closed-loop zero-waste discharge biorefinery model developed in this study based on novel waste lignocellulosic feedstock, annular bioreactor design and operation, ceramic membrane-based biomass separation and food packaging application of PHB nanocomposites demonstrated that the bioprocess is economical, sustainable and environmentally safe with potential industrial application.