



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
PhD-17 SHORT ABSTRACT OF THESIS

Name of the Student : Kuhelika Das

Roll Number : 206106011

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Name of Thesis Supervisor(s) : Prof. Vimal Katiyar

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**SHORT ABSTRACT**

This thesis explores the microbial production of pullulan and its applications in biomedical, cosmetic, and food-packaging sectors. Pullulan, an extracellular polysaccharide synthesized by *Aureobasidium pullulans* (*A. pullulans*), has gained attention as a sustainable alternative to synthetic polymers due to its biodegradability, biocompatibility, water solubility, and film-forming property. The research was driven by the increasing need for environmentally safe and biologically compatible materials that can be used in various industrial and healthcare applications. Pullulan production was optimized by shake-flask fermentation of *A. pullulans* NCIM 1049 using liquid sugarcane jaggery as a cost-effective carbon source. A systematic study of media components including jaggery, yeast extract, NaCl, K<sub>2</sub>HPO<sub>4</sub>, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, MgSO<sub>4</sub>·7H<sub>2</sub>O, and ZnSO<sub>4</sub>·5H<sub>2</sub>O, was performed using Plackett-Burman Design (PBD), which enabled the identification of significant factors influencing pullulan production. Response Surface Methodology (RSM) was used to determine the optimal concentrations of these media components for enhanced pullulan production. Beyond synthesis, the study explored the applications of pullulan in biomedical engineering, cosmetics, and food-packaging. A bilayered wound healing scaffold was prepared by combining an electrospun hydrophilic sublayer of pullulan/polyvinyl alcohol (PVA)/gum arabic containing gentamicin sulfate with a solvent-casted polylactic acid (PLA) top layer. This design addressed key challenges associated with traditional single-layered wound dressings, offering controlled gentamicin release and high swelling capacity for exudate absorption. It also exhibited favourable water vapour transmission rate (WVTR) and swelling index, as well as biocompatibility with human dermal fibroblasts, all of which are essential for accelerated healing. In another application-based study, coaxially electro-centrifugally spun core/sheath nanofibers composed of pullulan and poly(lactic-co-glycolic acid) (PLGA) were fabricated to co-deliver ciprofloxacin (CIP) and paclitaxel (PTX). These nanofibers exhibited tunable release kinetics with an initial burst followed by sustained delivery, demonstrating *in vitro* cytotoxic effects against melanoma A375 cells and highlighting their suitability as a dual drug delivery system. The functional properties of pullulan were also used in the preparation of an antibacterial skin-cream, where its film-forming ability and moisture retention were combined with the antimicrobial activity of turkey berry

(*Solanum torvum*, *S. torvum*) leaf extract. The formulation demonstrated favourable rheological characteristics, stability, and its heavy metal and arsenic content, microbial load, total fatty matter (TFM) and moisture content were determined. Additionally, active edible biocomposites were prepared using pullulan and gum arabic, functionalized with chitosan nanoparticles (NCS) and neem essential oil (NEO). The incorporation of NCS and NEO addressed the inherent high hydrophilicity and poor barrier properties of pullulan-based films. It also enhanced their mechanical strength, barrier performance, and surface hydrophobicity, while imparting antimicrobial, antioxidant, and UV-shielding properties. It was further applied as an edible coating for fresh-cut guava preservation, where it maintained quality attributes and extended shelf life under both ambient and refrigerated conditions.

