Optimization of Integrated Bioprocesses for Improved Production of Bacterial Nanocellulose from Lignocellulosic Biomass

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Environmental concerns have increased interest in biodegradable alternatives to synthetic plastics [1]. Nanocellulose is a promising material due to its renewable origin, biocompatibility, and versatile applications. Bacterial nanocellulose (BNC), unlike plant-derived forms (cellulose nanofibers and cellulose nanocrystals), is synthesized through microbial fermentation of sugars and is characterized by higher purity (without lignin or hemicellulose residual compounds), making it easier to use directly in biomedical or high-performance applications without extensive purification [2,3]. In this study, a combined bioprocess was optimized for BNC production from lignocellulosic residues. Agricultural and forestry biomass (wheat straw, beechwood) underwent mild OxiOrganosolv pretreatment [4], yielding cellulose-rich solids which were subsequently hydrolyzed enzymatically to fermentable sugars. These hydrolysates were used as carbon sources by *Komagataeibacter* sp. strains (*K. xylinus* and *K. medellinensis*) to produce BNC, and the results were compared to those employing pure sugars (glucose, xylose) as substrates. Daily monitoring of nanocellulose production and sugar consumption was performed, while the final BNC produced was characterized by Fourier transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA). Enzyme-mediated oxyfunctionalization of BNC with a lytic polysaccharide monooxygenase (LPMO) further enhanced the properties of BNC, thus increasing its value as a sustainable, high-performance material [5]. This work offers an optimized process for BNC production from renewable feedstocks, supporting scalable and sustainable material development.

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