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Production of propylene glycol from lignocellulosic waste biomass from the sugar industry in the associated biological and chemical processes

A new low-cost pathway for the production of high-value propylene glycol (PG) from the waste biomass from sugar industry is proposed in this dissertation. Selected strains of lactic acid bacteria efficiently convert sugars contained in enzymatic hydrolysates of sugar beet pulp and sugar beet leaves into calcium lactate, which after conversion into lactic acid (LA) and purification on activated carbon is reduced to propylene glycol via heterogenic catalysis at mild pressure and temperature conditions.

Enzymatic saccharifcation of sugar beet pulp and leaves requires the concerted action of cellulases, hemicellulases (including arabinosidases) and pectinases. In the research, a mixture of two commercial multienzyme preparations, *Viscozyme* and *Ultrafo Max*, containing these polysaccharidases, was found to efficiently saccharify polysaccharides contained in the sugar beet pulp and leaves to monosaccharides, assimilated by lactic acid bacteria.. The conditions of saccharifcation of waste biomass were optimized at the laboratory scale and used in semi-industrial scale in Sugar Factory at Dobrzelin. The monosaccharide profiles of sugar beet pulp and leaves hydrolysates were analyzed using high performance liquid chromatography or spectrophotometrically using enzymatic kits. Sugars present in hydrolysates were easily converted in biological processes into lactic acid using selected strains of lactic acid bacteria. Two different type of fermentation processes were considered: separate hydrolysis and fermentation (SHF) and simultaneous saccharifcation and fermentation (SSF). Simultaneous saccharifcation and fermentation proved particularly effective as a way of increasing the concentration of calcium lactate in the post-fermentation broths, especially supplemented with $CaCO_3$. In the industrial conventional biological method of lactic acid production, separation and downstream processing of pure LA account for up to 50% of production costs. Therefore, in this work, it proposes using a less pure solution of lactate ions as a feedstock. Post-fermentation broth was firstly acidified to pH 2–3 by the addition of sulphuric acid in order to obtain free lactic acid. Next, after $CaSO_4$ separation, active carbon was used for the purification of the post-fermentation broth to remove potential catalyst poisons, like amino acids. Finally, hydrogenation of lactic acid into propylene glycol, without excretion of LA from the fermentation broth, was performed over supported metallic catalysts, based mainly on ruthenium, under mild conditions.

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