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Process Development for the Conversion of Organic Waste into Valuable Products

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Abstract : Environmental concerns arising from the use of fossil fuels has increased the interest in the development of renewable and sustainable sources of energy. This would minimize the dependence on fossil fuels and serve as future alternatives. Organic wastes contain carbohydrates, proteins and lipids, which can be utilised as carbon sources for the production of bio-based products. Cellulose is the most abundant natural biopolymer, being the main structural component of lignocellulosic materials. The aim of this project is to develop a biological process for the hydrolysis and fermentation of organic wastes into ethanol and organic acids. The hydrolysis and fermentation processes are integrated in a single vessel using undefined mixed culture microorganisms. The anaerobic fermentation of microcrystalline cellulose was investigated in continuous and batch reactors at 25°C with an appropriate growth medium for cellulase formation, hydrolysis, and fermentation. The reactors were inoculated with soil (B1, C1, C3) or sludge from an anaerobic digester (B2, C2) and the breakdown of cellulose was monitored by measuring the production of ethanol, organic acids and the residual cellulose. The batch reactors B1 and B2 showed negligible microbial activity due to inhibition while the continuous reactors, C1, C2 and C3, exhibited little cellulose hydrolysis which was concealed by the cellulose accumulation in the reactor. At the end of the continuous operation, the reactors C1, C2 and C3 were operated under batch conditions. 48%, 34% and 42% cellulose had been fermented by day 88, 55 and 55 respectively of the batch fermentation. Acetic acid, ethanol, propionic acid and butyric acids were the main fermentation products in the reactors. A stable concentration of 0.6 g/l ethanol and 5 g/L acetic acid was maintained in C3 for several weeks due to reduced activity of methanogens caused by the decrease in pH. Thus far, the results have demonstrated that mixed microbial culture is capable of hydrolysing and fermenting cellulose under lenient conditions. The fermentation of cellulose has been found effective in a combination of continuous and batch processes.

Keywords : cellulose, hydrolysis, mixed culture, organic waste
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