

Research Stays 2019

Modelling lactic acid production in mixed culture fermentations

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Objectives

The objective of this research stay is to develop a metabolic model to be used as a tool in the design and optimization of lactic acid production processes using mixed cultures of microorganisms. Current metabolic models are not capable of predicting lactic acid production in the observed experimental conditions. In consequence, new models using different hypotheses need to be developed.

Methodology

Resource allocation theory states that cells have a maximum protein concentration and that the concentration of each section is linearly correlated with the flow rate catalyzed by those enzymatic proteins (Fig. 1). We built an FBA (flux balance analysis) model including these additional restrictions related with the resource allocation theory. The model simulates the competition between a bacteria producing acetate and butyrate (mixed acid fermentation) and a lactic acid bacteria in a CSTR. The aim is to predict the operational conditions that allow for the selective production of lactic acid.

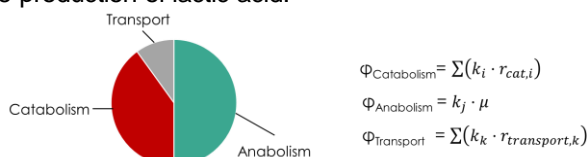


Fig.1: Cellular protein sections

Results

The results (Fig. 2) show that at high growth rates (imposed by the dilution rate) lactic acid bacteria outcome mixed acid bacteria. In these conditions, cells are limited by protein concentration and have to optimally tune the different fractions to maximize growth. In consequence, products needing short catabolic pathways that use less enzymes (as lactic acid) are favored as they allow for higher substrate uptake rates, even though cells harvest less energy from the substrate when yielding lactic acid.

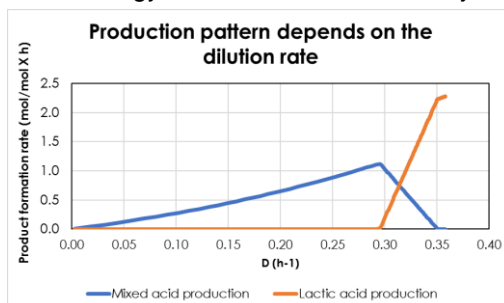


Fig.2: Product formation rate at different dilution rates in a CSTR

Highlights

The model developed identified the mechanism triggering lactic acid production in anaerobic mixed culture fermentations. With this information we can now design processes with a high selectivity on lactic acid using mixed cultures.

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