Determination of the Diffusion Coefficients of Glucose and Oxygen in Flocs of *Saccharomyces cerevisiae*

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Productivity increase in biotechnological processes can be achieved through the use of high cell density systems [1]. Among these, flocculation bioreactors present some advantages namely low associated costs and simple design [2]. Major problems related with such systems are those concerning mass transfer limitations inside cell flocs. These are very fragile structures, which pose experimental difficulties if parameters such as the effective diffusivity (De) and the external mass transfer coefficient (Kc) are to be evaluated, namely because of the very gentle agitation needed, which is essential to keep the integrity of the flocs during the course of the experiments.

The objective of this work is to determine the effective diffusivity of glucose and O_2, two important substrates, in aggregates of a highly flocculent strain of *Saccharomyces ærevisiae* (NRRL Y265). The exhaustion of those substrates in medium containing suspended inactivated flocs has been measured in a modified diffusion cell, used to avoid floc destruction. Floc size was determined by means of a computer aided image analysis technique [3].

The value of D_e was calculated using two methods: a first one, based on the analytical solutions of Fick's law of diffusion (neglecting external mass transfer resistance) and a second one, based on general mass balances of a component in the flocs and in the bulk phase (considering the existence of and external mass transfer resistance). This second method was, therefore, used to calculate K_c, as well.

The measured effective diffusivity for glucose in the yeast flocs was 1.10×10^{-10} $m^2\cdot s^{-1}$ and that for O_2 was found to be between 0.049×10^{-10} $m^2\cdot s^{-1}$ and 0.21×10^{-10} $m^2\cdot s^{-1}$. These values are around 17% and between 0.2 to 1% of the corresponding diffusivities of glucose and O_2 in pure water. The values of K_c were significant (when calculated), varying from 4.96×10^{-8} $m\cdot s^{-1}$ to 0.75×10^{-8} $m\cdot s^{-1}$, depending on the agitation rate. This demonstrates the importance of considering this parameter when evaluating D_e.

While the results for the effective diffusivity of glucose in flocs are in accordance with some of the data published in the literature for systems consisting of yeast cells entrapped in alginate beads [4], the results for O_2 are far below the reported values. The differences may be attributed not only to floc porosity but also to the influence of cell wall components, which may act as gels in exclusion chromatography, where smaller molecules are retained but larger molecules are not.

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