A STUDY OF SUBSTRATE AND PRODUCT INHIBITION IN KINETIC OF FERMENTATION PROCESS WITH IMMOBILIZED SACCHAROMYCES CEREVISIAE

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Abstract
One of the advantages of using immobilized yeast for fermentation process, is the tolerance increase in high levels of substrate or product concentration. Cell growth can be affected by the presence of inhibiting component in the beginning of the fermentation or as a result of product during the process. The objective of this study is to compare fermentations carried by two different immobilized yeast in high substrate and product concentrations, in terms of Monod’s constants. Entrapment and capsulation immobilization was performed with brewing strain of Saccharomyces cerevisiae from brewery “Birra Stela” and fermentation was carried in the Chemical Engineering Laboratory of Faculty of Natural Science, Tirana. Immobilized yeast are a good alternative to carry periodic and continuous fermentations because the microorganisms can be managed easier, is well preserved and it’s less exposed to the medium. Because of the protective layer of alginate surrounding the immobilized cells, the influence of inhibition factors is lower compared to free cell fermentation which stops in high sugar concentrations, 8.9° Bx. Comparing the two immobilized methods we can say that capsulated yeast are slightly more influenced by the surrounding medium conditions because cells are capsulated and not trapped into the matrix and the bead layer is thinner and less stable than the entrapment cells which make the entrapment immobilizes yeast more approachable for this conditions.

Key words: immobilized yeast, Entrapment, Capsulation, Fermentation, Bead, Inhibition

Introduction
Yeast immobilization techniques are used to improve some fermentation characteristics through physicochemical fixation of cells in solid matrix, protecting the cell from the surrounding medium. Specific growth rate is usually affected from the presence of inhibition components in the bioreactor. These components are present in the fermentation medium since the beginning, such as substrate in high concentration, or are produced during the process as biochemical products, such as alcohol production. Choosing the right immobilization technique is very important, because we have to protect the activity, without changing the morphology and physiology of the cells. The aim of this study is to find the suitable immobilization technique that protects the yeast cells providing a continuous fermentation performance.

Methods

These techniques are based on incorporating the cells in a porous, semi-permeable matrix, which prevents cells from diffusing into the surrounding medium allowing the mass transfer of nutrients and metabolites. Were used three different immobilization techniques:

- Entrapment Immobilization (fig: 1)
- Gel immobilization (fig: 2)
- Capsulation immobilization (fig: 3)
used for all cycles of fermentations. Immobilized beads were formed with the same pipette, but the dimensions were not the same, reflecting this in the fermentation performance. Respectively for each immobilized inoculated batch another one with free yeast cells was inoculated.

**Results and discussions**

We noticed that the surrounding matrix of the immobilized yeast decreases the impact of inhibition factors due to the lower exposure of cells in the surrounding medium. Despite the high sugar and product concentration the entrapment and capsulated cells (fig: 4 and 6) have a good fermentation performance comparing to free suspension cell fermentation. Regarding the gel immobilized fermentation (fig:5), results show that fermentation stops in high concentration and the structure of the matrix is dissolved during the second batch, releasing the yeast cells free (fig: 7).

We noted that fermentation starts sooner in capsulated immobilized batch and also the impact of product and substrate inhibition is decreased compared to entrapment immobilization. This notable difference is due to the dimension of the immobilized beads and the thin surrounding matrix layer. The inhibition effect is decreased when the diameter of the bead is increased (fig: 6).
Conclusions

- Bead dimension has a very important influence in decreasing the impact of product and substrate inhibition factor.
- Immobilization techniques increase tolerance to inhibition factors.
- Capsulated immobilization technique has a better fermentation performance in high substrate and product concentration.
- Gel immobilization has a low stability of the matrix, making this technique not suitable for continuous fermentation.
- Entrapment and capsulated immobilization show a high stability of the matrix and this are recommended techniques for further studies in continuous fermentation.
- Preserving the yeast characteristics, the same entrapment and capsulated immobilized beads can be used in many fermentation cycles.

References


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