INTEGRATION OF BIOCONVERSION AND DOWN-STREAM PROCESSING - STARCH HYDROLYSIS IN AN AQUEOUS TWO-PHASE SYSTEM.

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Starch hydrolysis is one of the major processes catalyzed by enzymes in industrial operation today. Since it deals with the enzymatic degradation of a macromolecular or even particulate substrate the use of soluble enzymes has been preferred. Since the enzymes used are rather cheap, it has been possible to operate the process under economically acceptable conditions, in spite of the consumption of enzymes. However, the reaction time is long because the biocatalytic density is kept rather low, since the soluble enzymes are not reused.

Consumption of enzymes and long reaction time are the characteristic features of the processes when dealing with macromolecular or particulate substrates.

In earlier reports we have demonstrated the feasibility to carry out enzymatic conversions in aqueous two-phase systems, performing the process in one of the phases and extracting the product to the other phase continuously (1,2). This would give a chance to carry out enzymatic degradation of macromolecular substrates without losing the enzyme used.

Integration of the bioconversion step and the first step of down-stream processing can be used as a means to increase the productivity of bio-processes. This integration also gives the possibility to run the bioconversion in a continuous mode. We demonstrate the use of an aqueous two-phase system in combination with ultrafiltration to accomplish this.

Conversion of native starch to glucose by α-amylase (Termamyl, Novo) and glucoamylase (SAN 150, Novo) was carried out in a mixer-settler reactor containing an aqueous two-phase system composed of 5% PEG 20M and 3% crude dextran. The top-phase in the settling part of the reactor was continuously ultrafiltered. In this way, a continuous stream of glucose was obtained; the phase forming polymers as well as the starch degrading enzymes were recycled to the reactor, and clogging of the ultrafiltration membranes was avoided.

This process was carried out continuously for 8 days using a 10% starch suspension (waxy maize) as substrate. The productivity during the experiment was about 13 g/l*h. The enzyme activities in the top and bottom phases and in the mixing chamber were also monitored throughout the experiment.
The settling time for phase systems containing solid starch and varying amounts of PEG and crude dextran was studied.

The ratio between α-amylase and glucoamylase, to obtain optimal activity, as well as the activity and stability of enzyme mixtures was studied both in buffer media and in media containing the polymers to be used in the enzyme reactor. The enzymes were found to be more active and stable in media containing polymers than in the buffer solutions used.
The optimum pH, temperature and ionic strength were determined.

References

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