PHYSIOLOGICAL ASPECTS OF BIOTECHNOLOGICAL XYLITOL PRODUCTION FROM HEMICELLULOSIC SUBSTRATES

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Introduction

Considerable amounts of agricultural residues have been produced by several technological processes. Xylitol, is one product that has been produced from hemicellulosic biomass of these residues by fermentation processes. Xylitol is a sweetener that has high food, odontological and clinical applications (1). Large-scale xylitol production occurs by chemical process from catalytic hidrogenation of xylose in the presence of Nickel catalyst (2). Xylitol produced by this process can contain toxic residues from the catalyst, that increase the cost of the downstream processing. Xylitol produced by biotechnological means is an alternative process that appears to be a more efficient and economical approach. This process does not require the previous purification of xylose since this sugar is converted directly in xylitol by microorganisms in the hemicellulosic hydrolysates. However, the efficiency and productivity of this fermentation process is influenced by phisiological parameters that affect the xylose metabolism.

In this report we show some more significant physiological aspects that influence the xylitol production by *Candida guilliermondii* yeast in hemicelulosic hydrolysates.

Materials and Methods

C. guilliermondii FTI 20037 was used in this work. The inoculum was grown in a synthetic medium containing xylose as the major carbon source, in Erlenmeyer flasks at 200 rpm/30 ℃ for 24-40 h. The fermentation were conducted in synthetic medium containing 70 g/L^{-1} of xylose or in hemicellulosic hydrolysates obtained from acid hydrolysis of sugar cane bagasse and rice straw (3, 4). The fermentation runs were performed in Erlenmeyer flasks by shaking or in a stirred tank bioreactor under different conditions using the synthetic medium or in hemicellulosic hydrolysates containing nutrients 3, 4).

Analytical Methods

Cell concentration was determined by the relationship between optical density (600 nm) and dry cell weight or by the number of the cells using a Neubauer Chamber. Xylose, glucose, arabinose and xylitol were determined by high performance liquid cromatography (HPLC).

Results and Discussion

The biological xylitol synthesis is regulated by several physiological parameters. This synthesis occurs since the xylose-fermenting yeast's produce xylose reductase enzyme that catalizes the xylose reduction into xylitol as the first step in xylose metabolism. Under all the conditions studied, this strain of yeast was able to excrete xylitol at different rates.

The effect of the temperature was not so pronounced, best results on xylitol production were acheived at 30 ℃. For synthetic mediun it is possible to conduct this fermentation process at low pH (4.0-5.0), but in hemicelullosic substrates the better fermentation runs occurred at a higher pH (5.3-6.0). This fact is due to the presence of inhibitors like acetic acid on hydrolysates and its effect on cellular membrane (5). Xylitol production was stimulated by high xylose concentration, and the best Y p/s value (0.83 g/g) were acheived using 70 g/L of initial xylose. The presence of glucose, acetic acid and furfural showed a negative effect on biosyntesis of xylitol. The aeration rate proved to be the major physiological factor that affects the xylitol production, and the best results are acheived using a lower oxygen input or oxygen limitation This result can be explained by the effect of the oxygen on the xylose metabolism and the regeneration of cofactors for the xylose reductase enzyme.

According to the results, the biotechnological approach for xylitol production appears to be efficient and high xylitol concentrations can be obtained under controlled fermentation conditions. The *C. guilliermondii* yeast used in this bioprocess is potentially useful for xylitol production from hemicellulosic substrates due to the xylitol yields acheived that are comparable to that obtained in synthetic medium.

1. Hyvönen L, *et al.* Advances in Food Research 1982;28(3):373-403.

2. Jaffe GM, *et al.* US Patent 3.784.408 Dep. 16/9/70 Pub 1974;08/01.

3. Felipe, *et al.* Arquivos de Biologia e Tecnologia 1993;36(1):103-114.

4. Roberto, *et al.* Biotechnology Letters 1994;16(11):1211-1216.

5. Felipe, *et al.* Journal of Basic Microbiology 1995;35.