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Application of response surface methodology for the optimization of arabinose biotransformation to arabitol by *Candida parapsilosis*

Research Article

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Abstract: L-arabitol, a polyol with applications in the food and pharmaceutical industries, is secreted by different yeasts, e.g., *Candida* spp., *Pichia* spp., and *Debaryomyces* spp. The process of its biotechnological production is highly dependent on the physical and chemical conditions of culture. The aim of this study was to use statistical response surface methodology (RSM) to optimize the biotransformation of L-arabinose to arabitol by *Candida parapsilosis*, a yeast species able to assimilate pentoses. Batch cultures of the yeast were prepared following a Plackett-Burman design for seven variables. Following this, rotation speed, temperature, and L-arabinose concentration were chosen for a central composite design (CCD) experiment, which was carried out to optimize the production L-arabitol. The results showed that the optimal levels for the three factors were: rotation speed 150 rpm, temperature 28°C, and L-arabinose concentration 32.5 g/l. The predicted concentration of arabitol after two days of incubation of *C. parapsilosis* under the above conditions was 14.3 g/l. The value of R^2=0.8323 suggested that this model was well-fitted to the experimental data, and this was confirmed during a verification experiment.

Keywords: *Central composite design • Plackett-Burman design • RSM • Yeast*

1. Introduction

L-arabitol is a pentitol that has been classified, together with xylitol, as one of the top 12 biomass-derivable building block chemicals. Because of its low-calorific — only 0.2 kcal/g, low-glycemic, low-insulinemic, anticariogenic, and prebiotic character, this polyol can be used in many of the known applications of xylitol, for example as a natural sweetener, a dental caries reducer, and a sugar substitute for diabetic patients [1]. Together with other polyols, it is used in the food and pharmaceutical industries as a texturing agent, a humectant, a softener, and a color stabilizer. Chemical production of arabitol is expensive, requiring the use of chromatographic purification steps [2]. Arabitol can also be produced through the biotransformation of appropriate sugars, e.g., those obtained from hydrolyzates of the hemicellulosic fraction of plant biomass [3,4]. So far, the following yeast genera have been used to produce arabitol from L-arabinose: *Debaryomyces*, *Candida*, *Pichia*, *Wickerhamomyces*, and *Saccharomycopsis* [1]. The first screening to identify yeasts and fungi that are able to produce arabitol from L-arabinose under oxygen-limiting conditions was reported by McMillan and Boynton [5]. They observed that xylose-fermenting yeasts converted L-arabinose to arabitol, and not to ethanol [5]. Saha and Bothast [4] investigated 49 yeast strains capable of growing on L-arabinose and concluded that *Candida entomaea* NRRL Y-7785 and *Pichia guilliermondii* NRRL Y-2075 were superior secretors of L-arabitol (a yield of about 0.7 g/g). Girio *et al*. [3] observed the ability of *Debaryomyces hansenii* to produce arabitol from L-arabinose in a batch culture at 30°C. Kordowska-Wiater *et al*. [6] reported that *C. parapsilosis* DSM 70125, *C. shehatae* ATCC 22984, and *P. guilliermondii* DSM 70052 were efficient producers of arabitol at concentrations of 14.0 g/l, 8.5 g/l, and 6.9 g/l, respectively, produced from 20 g/l

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