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ORIGINAL PAPER

Airlift reactor – membrane extraction hybrid system for aroma production

Mário Mihaľ, Sean Peter Gavin, Jozef Markoš*

Institute of Chemical and Environmental Engineering, Faculty of Chemical and Food Technology, Slovak University of Technology, Radlinského 9, 812 97 Bratislava, Slovakia

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In recent times, environmental production methods and organic products are increasingly sought after in food, perfume, and cosmetic industries, where the products are consumed or come into direct contact with humans. One such additive is 2-phenylethanol, an alcoholic aromatic rose like smell compound, mainly used as a flavor and aroma. 2-Phenylethanol can be produced by bioconversion from L-phenylalanine using *Saccharomyces cerevisiae*. This type of biotransformation is strongly limited by product inhibition which allows reaching the maximum concentration of 2-phenylethanol, 4 g L^{-1}, in an ordinary batch, fed-batch, or chemostat bioreactor. The main aim of the presented work was to study the possible yield increase of 2-phenylethanol in a hybrid system consisting of membrane extraction performed by a hollow fiber membrane module immersed in the downcomer of an airlift reactor. Such hybrid system can be used to remove 2-phenylethanol from the fermentation medium and thus to overcome the product inhibition of biotransformation. In this paper, the influence of biomass on membrane extraction of 2-phenylethanol from aqueous solution in an airlift reactor to alkanes at different operational conditions was studied. The measured extraction kinetics was compared with the predictions obtained by a mathematical model. Hydrodynamics of the hybrid system was also studied.

Keywords: 2-phenylethanol, airlift reactor, hollow fiber, immersed module, intensification, membrane extraction

Introduction

Recently, environmental production methods and organic products have attracted increasing interest in food, perfume, and cosmetic industries, where the products are consumed or come into direct contact with humans. For this reason it is favorable that the flavoring and aroma additives used in these industries can also be considered as organic so as to allow the final product to be claimed "natural". One such common additive is 2-phenylethanol (PEA) which is an alcoholic aromatic with a rose like smell; it has various applications but is mainly used as a flavor and aroma in the perfume, food, and cosmetic industries.

PEA is produced naturally in many flowers and can be extracted from the essential oils of flowers. The amount of PEA in flowers is relatively low and expensive to extract. A cheap way of PEA production is its chemical synthesis. According to the USA and the European Union legislation (US Department of Agriculture, 1985; Council of the European Communities, 1988), synthesized flavor compounds are restricted in food and cosmetics, which results in high demand for natural PEA. The same legislation has, however, classified that flavor substances can be deemed "natural" if produced using an enzymatic or microbial process, with precursors which have also to be natural. This allows employing microorganisms to carry out chemical reactions producing PEA.

One example of such a production is the bioconversion of L-phenylalanine using *Saccharomyces cerevisiae* under growth conditions. However, PEA is a

*Corresponding author, e-mail: jozef.markos@stuba.sk