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## SOLVENT-FREE ENZYMATIC SYNTHESIS OF PENTYL ESTERS IN A BATCH REACTOR USING A COMMERCIAL IMMOBILIZED LIPASE

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### Abstract

Short-chain esters are compounds frequently used in different industrial sectors such as food, cosmetics and pharmaceuticals, among others. For this reason, investigations are currently being carried out to improve the sustainability of the esterification processes that produce these compounds, since the catalysts (acids, resins, ionic liquids, etc.) used to improve the efficiency of these reactions are not environmentally friendly. However, a cleaner alternative is to catalyze the liquid phase esterification of carboxylic acids with alcohols, using immobilized

lipases, to form the corresponding ester and water,



because those enzymes are selective in said reactive processes, since they even avoid unwanted secondary reactions. The catalytic activity of lipases improves at moderate temperatures (30-70 °C), causing a decrease in the necessary energy consumption of the reaction, compared to other options. In addition, the immobilization of the enzyme on porous solid supports generates certain advantages on the esterification process, typical of heterogeneous catalysis, such as the simple separation of the catalyst from the reaction medium, and the possibility of reusing the enzyme in successive reaction cycles.<sup>(1)</sup> In addition, according to international regulations (CE, 1333/2008, U.S. Dpt. of Health & Human Services), the products obtained via enzymatic synthesis are labelled as "natural", so their value exceeds to those others produced by other routes. However, despite their potential, these enzymatic processes, in general, are not yet industrially exploited. One of the main reasons is that until recently most scientific papers recommended operating with very low concentrations of reagents to avoid enzyme denaturation. However, the solvent-free systems (SFS) are increasing their use,<sup>(2)</sup> since the presence of an additional solvent in a process implies an extra cost and also the creation of an extra unit for its recovery, with the corresponding energy consumption.

In this work we present the results of the enzymatic synthesis of pentyl acetate and propanoate, obtained at 40 °C, from the corresponding carboxylic acid and pentan-1-ol, using an immobilized commercial lipase. The effects of: (a) acid/alcohol molar ratio, and (b), the reuse of the enzyme on esterification rate and conversion are analyzed. Reactions are carried out in a stirred batch reactor at constant temperature, stirring, and enzyme/acid mass ratio throughout all experiments. The reaction kinetics is evaluated from the remaining carboxylic acid concentration over time. The results show that the solvent-free reaction occurs with high rates and conversions under certain conditions, so the use of a solvent is not required, which is advantageous with respect to the volumetric productivity of the process and the subsequent ester purification steps. In addition, enzyme reuse was performed for 10 successive cycles under the aforementioned conditions with acid/alcohol=1/2, with no signs of enzyme damage.



### References

- [1] T. Garcia, A. Coteron, M. Martinez, J. Aracil. *Chem. Eng. Sci.* **2000**, 55(8), 1411-1423.  
[2] G. Sandoval, J. S. Condoret, P. Monsan, A. Marty. *Biotech. & Bioeng.* **2002**, 78(3), 313-320.