

Enantioselective esterification with triglycerides in supercritical carbon dioxide

Iláikó Kmezz,¹ Sabine Kareth,² Ágnes Szécsényi¹; Zsófia Varga¹; Pascal Degen²; Elsa Soto¹; Alina Hanu²; Edit Székely^{1*}

¹Budapest University of Technology and Economics, Department of Chemical and Environmental Process Engineering, Budapest, Hungary

²Ruhr-Universität Bochum, Lehrstuhl für Verfahrenstechnische Transportprozesse (VTP), Fakultät für Maschinenbau, Bochum, Germany

There is a continuously growing need in the chemical industry for efficient and low cost routes to pure enantiomers. Enzyme catalyzed transesterification reactions are among the most promising enantioseparation techniques of low environmental impact. However, the typically applied esterification agent is the highly volatile and toxic vinyl acetate¹, because due to the oxo-enol tautomerisation of the aldehyde byproduct the equilibrium reaction can reach full conversion. Lipases typically maintain their activities in organic and non-conventional solvents, like ionic liquids or supercritical fluids. Dense carbon dioxide is GRAS (generally regarded as safe) and environmentally benign solvent and its dissolving power can be easily controlled with pressure and temperature and diffusion coefficients are by orders of magnitude higher than in liquids².

Our objective was to perform the enantioselective esterification with triglycerides, as cheap and natural reagents in liquid and supercritical carbon dioxide solvent. As model compound racemic 1-phenylethanol was selected, as well defined triglycerides triacetin and tributin were applied. The reaction was catalyzed by commercial *Candida antarctica* lipase B (CALB) immobilized in macroporous acrylic resin. Experiments were either performed in view cell units or in autoclaves, with possibility of constant pressure and temperature sampling, in 6-21 MPa pressure and 20 – 65 °C temperature ranges. Enantioselectivities, reaction rates and Michaelis-Menten constants were determined and compared with results of atmospheric reference experiments in *n*-hexane or neat.

Both triacetin and tributin are efficient esterification reagents and the reaction is highly enantioselective ($E>1000$) in all conditions studied. In dense carbon dioxide reaction rates are higher than in *n*-hexane under the same conditions except pressure, while neat reactions were the fastest. Slight increase in reaction rates were observed with increasing pressure in cases of homogenous phase reactions, but the opposing effect was observed when the pressure increase resulted in a homogeneous fluid reaction phase instead of the liquid – fluid biphasic system. Equilibrium enantiomeric excess values (80-98 %) of remaining alcohol slightly depends on pressure, temperature and solvent, while phase equilibrium strongly depends on pressure especially when tributin was applied, which is very promising for further developments on separation of products.

The research work was supported by the Hungarian National Scientific Research Fund (OTKA K108979). E.S. is thankful for her Erasmus scholarship, E.Sz. would like to thank the János Bolyai Fellowship of Hungarian Academy of Sciences.

1. J. Otera, J. Nishikido: Esterification, Methods, Reactions, and Applications, 2nd Ed., WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2010.
2. Bertucco A, Vetter G (eds.), High Pressure Process Technology: Fundamentals and Applications. Amsterdam: Elsevier, 2001.

*Corresponding author: sz-edit@mail.bme.hu

Keywords: kinetic resolution, enzymatic catalysis, supercritical carbon dioxide, triglycerides