Active and stable biocatalyst for the continuous flow synthesis of C8-C18 carboxylic acids esters of biomass-derived furfuryl alcohol

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The availability of lignocellulosic biomass offers a promising avenue for sustainable chemical manufacturing, aligning with the principles of circular economy and carbon neutrality. As the demand for selective catalysts and environmentally friendly production methods continues to grow, biocatalysis emerges as a crucial solution. The biodegradability and high activity of enzymes enable their action under mild conditions, ensuring safety and effectiveness for the environment. However, challenges persist in improving the recycling and stabilization of enzymes in chemical processes [1, 2].

To respond these challenges, we explored immobilization methods employing various types of silica-based supports. Previous literature indicates that hydrophobic surfaces increased lipase activity, and introducing surface modifiers, such as alkyl groups on silica, enhances catalytic performance [3, 4]. Therefore, we modified $MgO{\cdot}SiO_2$ matrix with triethoxy(octyl)silane (C_8) to maintain the hydrophobic properties of the material. The modified matrix served as both a support and stabilizer for adsorbed lipase from *Aspergillus oryzae* (LAO). By combining expertise in biocatalyst design and support surface chemistry, we demonstrated the first application of a continuous flow system for furfuryl ester synthesis using the $MgO{\cdot}SiO_2$-C_8-LAO biocatalyst.

Initial studies conducted in a batch system showed excellent catalytic activity of $MgO{\cdot}SiO_2$-C_8-LAO in the esterification of furfuryl alcohol and caprylic acid, with 90% conversion observed after 45 min. The biocatalyst exhibited versatility towards other acids as well, achieving high conversions within short reaction times. Encouraged by these promising results, we transitioned to continuous flow synthesis, which proved to be an effective strategy for enhancing biocatalytic ester production. The transformation from batch to flow synthesis enabled us to achieve 97% conversion of furfuryl alcohol with optimized flow parameters. The space-yield-time for the active $MgO{\cdot}SiO_2$-C_8-LAO in the continuous flow system reached 458.4 ($gh^{-1}mL^{-1}mg^{-1}$). Visual representation of the designed continuous flow synthesis of furfuryl caprylate in the presence of the $MgO{\cdot}SiO_2$-C_8-LAO biocatalyst is presented in Figure 1.

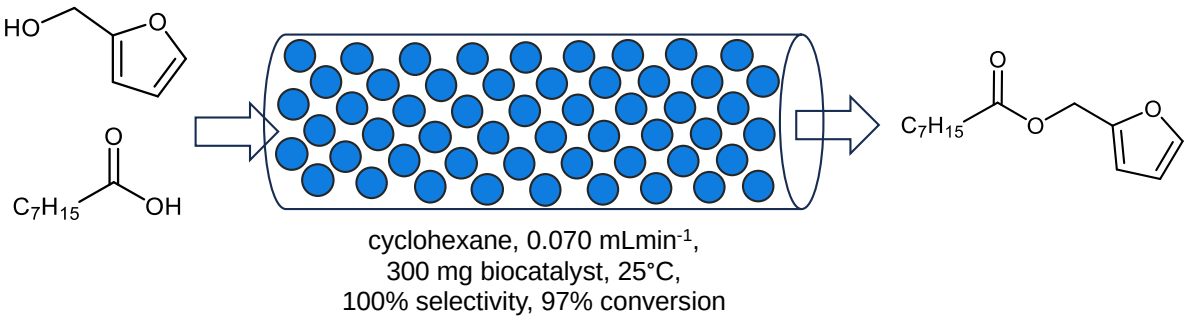

Figure 1. Continuous flow synthesis of furfuryl caprylate ester in the presence of $MgO{\cdot}SiO_2$-C_8-LAO.

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