ENZYMATIC SYNTHESIS OF A SURFACTANT ESTER CATALYZED BY LIPASE IMMOBILIZED ON FUNCTIONALIZED SiO₂-BASED SUPPORT

Patricia Ortiz¹, Adriano Aguiar²
¹Universidade Federal de Minas Gerais, ²Universidade Federal de Alfenas

Biosurfactants are a promising alternative in replacing fossil fuel derived chemical surfactants due to their ideal surfactant properties, high biodegradability and biocompatibility [1]. Lipase-catalyzed esterification reactions offer an attractive alternative to traditional processes employing chemical catalysts, due to their high selectivity and the requirement for mild reaction conditions. The major disadvantages of the use of free lipases are their separation for later application and poor solvent tolerance capability. These problems can be overcome by immobilization, physical adsorption via hydrophobic interaction is the preferred immobilization protocol of lipases due to it interfacial activation mechanism [2]. In this study, a surfactant ester was synthesized via direct esterification reaction using immobilized lipase from Thermomyces lanuginosus (TLL) as potential biocatalyst. TLL was immobilized via hydrophobic interactions in a SiO₂-based support prepared by hydrothermal treatment of rice husk silica and functionalized with triethoxy(octyl)silane according to the methodology proposed by Machado et al. (2019) [3]. The heterogeneous biocatalysts were prepared by incubating 1 g of support in 19 mL of enzyme solution prepared at pH 7.0 (5 mM sodium a phosphate buffer) and containing protein loading of 40 mg/g support. Immobilization parameters: a) immobilized protein (IP) and, b) hydrolytic activity - hydrolysis of olive oil emulsion (HA) were determined as described by Machado et al. (2019). The esterification reactions were performed by incubating 6 mL of reaction mixture containing 1 M of acid at molar ratio of 1:3 (palmitic acid:solketal) in heptane medium and 800 U of prepared biocatalyst, at 56 °C and 240 rpm. Samples (100 µL) were periodically withdrawn from the reaction mixture and titrated (30 mM NaOH solution) to determine the residual acid concentration and consequently conversion (%). Reusability tests were performed after 6 consecutive cycles of ester synthesis in batch systems. Ester conversion percentage was estimated at the end of each run according to Machado et al. (2019). The results indicated that the prepared biocatalyst was highly active in the hydrolysis reaction – HA of 656.0 ± 23.9 U g⁻¹ and IP of 21.2 ± 2.2 mg g⁻¹ of support. In the esterification reaction, the biocatalyst presented high catalytic activity with maximum conversion around 84% after 150 min of reaction. The biocatalyst also showed satisfactory reuse stability, retaining 90% of its initial activity after 6 consecutive cycles (150 min) of solketal palmitate ester synthesis in batch systems. These results indicate the relevant use of the prepared biocatalyst prepared by hydrophilic adsorption of TLL on functionalized support using RHS as silica source, a renewable and low-cost support, to synthesize a surfactant ester due to its high catalytic activity and reusability.