RECYCLABLE MULTILAYER MAGNETIC BIOCATALYST FOR SYNTHESIS OF NATURAL ESTERS

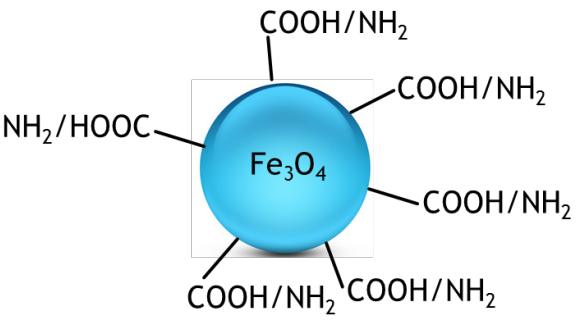
Goal of the project:

The main goal of the project is to develop a demonstration model for a new biocatalyst containing a designed magnetic core and hybrid layers (organic and silica) that allow the immobilization of enzymes. The validation of the model will be accomplished through the effectiveness of the product in a specific reaction, to demonstrate that such a biocatalyst is stable, reproducible, recyclable and able to synthesize esters that are accepted as naturals according to the EC regulations (Regulation no 1334/2008 of the European Parliament and subsequent amendments).

Short description of the project

The key objective is a comprehensive evaluation of the magnetic manipulation efficiency of enzyme functionalized magnetic nanocomposites obtained by applying cost-effective preparation procedures and manifold advanced characterization and testing techniques. The chemical composition, structure, size distribution, magneto- responsiveness and size, as well as the enzyme loading capability will be designed to fulfill the requirements for efficient biocatalysis and easy recovery of the enzyme even from viscous media, avoiding the contamination of the product and allowing its recognition as "food-grade".

An innovative multilayer technology will accomplish the demonstrative model. The immobilization of lipase on controlled-size magnetic core nanoparticles will be combined with stabilization of the hybrid composite through a sol-gel silica shell. The size and magnetic properties of the core particles will be adjusted to allow the optimal catalytic efficiency.



Project implemented by

- University Politehnica Timişoara-Project leader
- National Institute for Research and Development of Isotopic and Molecular Technologies INCDTIM Cluj-Napoca - Project partner

Implementation period

30.01.2017- 29.06.2018

Main activities

The objective of the project is to develop a demonstration model for a new biocatalyst containing a designed magnetic core and hybrid layers (organic and silicon) that allow the immobilization of enzymes, as well as the validation of the model through its effectiveness in a specific reaction of aroma ester synthesis.

Stage 1 (2017, 12 months) – Development of a new multilayer magnetic biocatalyst

Stage 2 (2017, 12 month) – Synthesis of natural esters in repeated cycles using the multilayer magnetic biocatalyst

Results

The research carried out in this stage was focused on:

- development of a new multilayer magnetic catalyst by preparation of various magnetic nanoparticles;
- immobilization studies of *Candida antarctica* B lipase on these supports;
- investigation of the resulted biocatalysts in esterification reactions.

Magnetic clusters functionalized with amino and carboxyl groups were obtained, and their structural, morphological and their magnetic characteristics were determined by instrumental methods, like as XPS spectroscopy. A second direction was the production of single-core magnetic nanoparticles stabilized by coating with various surfactants. These nanoparticles were thoroughly characterized by FT-IR, TEM, and XPS.

For both multi-core and single-core magnetic particles, the hydrodynamic diameters and zeta potential values have been also determined. The investigations concerning lipase immobilization included the influence of the nature and concentration of the binding agent (carbodiimide or glutaraldehyde), as well as finding of the optimal reaction conditions for covalent binding. The hydrolytic and esterification activities of the obtained biocatalysts were assayed on standard substrates.
Visit also: http://chim.upt.ro/ro/cercetare/proiecte-de-cercetare/247-pn-iii-p2-2-1-ped-2016-0168

Publications in the field of the project:

1. A. Nan, I. V. Ganea, R. Turcu, Physicochemical properties of a new magnetic nanostructure based on poly(benzofurane-co-arylacetic acid), *Analytical Letters*, accepted, DOI: 10.1080/00032719.2017.1400041
2. A. Todea, D. Aparaschivei, V. Badea, C.G. Boeriu, F. Peter, Biocatalytic route for the synthesis of oligoesters of hydroxy-fatty acids and ε-caprolactone *Biotechnology Journal*, 2018, accepted.

Presentations at conferences:

1. R. Turcu, C. Vasilescu, A. Nan, T. Radu, I. Crăciunescu, A. Petran, M. Cîrcu, A. Bunge, F. Peter, Magnetic nanostructures with functional coating specifically designed for immobilization of enzymes, *2nd World Congress & Expo on Materials Science and Nanoscience*, September 25-27, Valencia, Spain.
2. C. Vasilescu, I. Benea, C. Paul, A. Todea, R. Turcu, F. Peter, Immobilization of lipase from *Candida antarctica* B by covalent binding onto magnetic supports, *New Trends and Strategies in the Chemistry of Advanced Materials with Relevance in Biological Systems, Technique and Environmental Protection*, 10th Edition, June 08-09, 2017, Timișoara, Romania.

Applicability and transferability of the results

This custom-made immobilized lipase will be able to catalyze the synthesis of natural esters from natural acids and natural alcohols. There is a high demand for food aroma esters recognized as naturals and the biocatalytic way is the best possibility to synthesize them. Superparamagnetic iron oxide nanoparticles (IONPs) in highly stable ferrofluid formulations will be used to fabricate functionalized magneto-responsive nanobeads for lipase immobilization, resulting in manifold reusable nanoparticle systems of high catalytic efficiency.

Financed through/by

Romanian Authority for Scientific Research and Innovation (UEFISCDI), project number PN-III-P2-2.1-PED-2016-0168, within PNCDI III

Research Center

Research Centre in Organic, Macromolecular and Natural Compounds Chemistry and Engineering

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