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Editorial

Special Issue "Biocatalysts: Design and Application"

Cesar Mateo [1,*] and Jose M. Palomo [2,*]

[1] Group of Chemical Processes Catalyzed by Enzymes, Department of Biocatalysis, Institute of Catalysis (ICP-CSIC), Cantoblanco, Campus UAM, 28049 Madrid, Spain
[2] Group of Chemical Biology and Biocatalysis, Department of Biocatalysis, Institute of Catalysis (ICP-CSIC), Cantoblanco, Campus UAM, 28049 Madrid, Spain
* Correspondence: ce.mateo@icp.csic.es (C.M.); josempalomo@icp.csic.es (J.M.P.)

The use of biocatalysts in chemical reactions is of great interest because reactions can be carried out under very mild and green conditions. Within biocatalysis there are different areas that are key when using this type of process for the synthesis of products of interest. In the first place is the selection of the best type of biocatalyst to carry out the reaction so that both enzymes and whole cells can be used to catalyze the reaction of interest. In addition, once the biocatalyst has been selected, there would be the study of the design and preparation of both enzymatic and cell catalysts that are more active and robust so that in the case of enzymes they are immobilized and therefore heterogeneous catalysts and in the case of whole cells that are modified so that the compound of interest is produced in an optimal way, overexpressing the enzymes with the activities of interest and minimizing the activities that may lead to the consumption of the product of interest or that catalyze unwanted parallel reactions. The last step would be the optimization of the reaction conditions to optimize the production of the compound of interest. For this, it is important to choose the best activity conditions for the biocatalysts but combined with the choice of the parameters that may intervene in the thermodynamics of the reaction.

In this issue different types of biocatalysts and methodologies have been published. Thus, different papers using enzymes as catalysts have been published.

Within the use of enzymes as biocatalysts, lipases, and esterases are one of the most widely used enzymes, which is why different papers have been published both regarding their use and the optimization of their production:

Dong et al. have immobilized a new esterases from *Bacillus altitudinis* encoded by est_{BAS} gene onto an Epoxy Resin. In this way, they have achieved catalysts with a high enzymatic load and more thermostable that has used to synthesize chloramphenicol palmitate by regioselective modification at the primary hydroxyl group, obtaining yields of 94.7% in 24 h [1].

Toro et al. Co-immobilized different lipases from *Thermomyces lanuginosus* (TLL), *Candida antarctica* (CALB) and *Rhizomocur miehei* (RML) on supports as Lewatit®VPOC1600 (LW) and Purolite®ECR1604 (PU), to produce new Combi-lipases (CL) systems to produce fatty acid ethyl esters (EE) which are the main component of ethylic biodiesel [2].

Li et al. immobilized and characterized a system in which the enzyme Phospholipase A1 (PLA1) has been used as the biocatalyst to produce high value L-α-glycerylphosphorylcholine (L-α-GPC) through hydrolysis of phosphatidylcholine (PC). For this, they used a simple co-precipitation method to encapsulate PLA1 in a metal–surfactant nanocomposite (MSNC), then modified it using alkalescent 2-Methylimidazole (2-Melm) to promote catalytic efficiency in biphasic systems by creating microenvironments [3].

Other study with an immobilized sterase was published by Meng et al. [4]. In this study, lipase-immobilized mesoporous silica particles (LMSPs) are employed as both Pickering stabilizers and biocatalysts. A series of alkyl silanes with the different carbon length are used to modify LMSPs to obtain suitable wettability and enlarge the interfacial area of Pickering emulsion improving the yields and allowing the reusability.

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A study of production and optimization of a T1 lipase was presented. The growth of recombinant *Escherichia coli* and expression of T1 lipase were tested using different agro-industrial wastes as carbon and nitrogen sources by conventional method. The study from Nooh et al. optimized the lipase production minimizing the operation costs [5].

Leśniarek et al. published a study using Lecitase® Ultra as a novel alternative biocatalyst for the kinetic resolution of model racemic allyl esters of (E)-4-phenylbut-3-en-3-ol with high enantiomeric escesses [6].

Finally, Djaalab et al. used the *Candida rugosa* (CRL) was developed for detection of amlodipine besylate drug (AMD) using the cyclic voltammetric method. The catalyst was performed with biodegradable material using a mixture of polyaniline iron oxide and gelatin [7].

In addition, other processes using other enzymes as catalysts have been published:

Rodrigues de Melo et al. They immobilized a b-glucosidase on agarose supports and using post-immobilization techniques with the use of polyfunctional polymers (PEI) obtained catalysts with improved stabilities [8].

Nicotine hydroxylase from Pseudomonas sp. ZZ-5 (HSPHZZ) was immobilized on Immobead 150 to produce 2,5-dihydroxypyridine (2,5-DHP) from 6-hydroxy-3-succinoylpyridine (HSP) in the presence of nicotinamide adenine dinucleotide (NADH) and flavin adenine dinucleotide (FAD) (Dong et al.) [9].

Chen et al. developed Proteinases from a Novel Wild *Lactobacillus plantarum* LP69 for their use in hydrolysis of whey protein, lactoglobulin, and casein at industrial level. The extraction conditions and properties were evaluated [10].

In addition, a novel mimetic artificial peroxidase was designed (Yuan et al.) [11]. This enzyme was stable against different conditions as pHs, temperatures, and solvents. The catalyst was used for glucose detection.

The use of modified cells for production of different compounds was one of the strongest points in this issue:

In the paper of Chen et al. a bioprocess for the asymmetric reduction of 4-(trifluoromethyl) acetophenone to (R)-1-[4-(trifluoromethyl)phenyl]ethanol (an antagonist against HIV) was developed by recombinant Escherichia coli cells with excellent enantioselectivity was presented [12].

Petkevičius et al. employed modified whole cells of *Escherichia coli* bearing phenol monooxygenase-like protein PmlABCDEF (PML monooxygenase) for the synthesis of aromatic N-oxides with improved yields compared with the wild type PML [13].

Dolejš et al. immobilized the anaerobic bacterium *Clostridium butyricum* into a polyvinyl alcohol (PVA) hydrogel. The use of this biocatalyst and the reaction optimization for the fermentation of glycerol to produce 1,3-propanediol is described [14].

Zhang et al. described the Isolation of a *Bacillus Aryabhattai* Strain for the Resolution of (R, S)-Ethyl Indoline-2-Carboxylate to Produce (S)-Indoline-2-Carboxylic Acid with yields of 33% and eep of 96% [15].

Yang et al. studied the application of an amylosucrase (ASase) from *Xanthomonas campestris* pv. *campestris* str. ATCC 33913 (XcAS) expressed efficiently in *Escherichia coli* JM109 obtaining the highest reported yield by engineered strains [16].

The issue is closed with two different reviews:

The first published by Krivoruchko et al. described the *Rhodococcus* Biocatalysts for Environmental Biotechnologies focusing on *Rhodococcus* cell immobilization in detail (methods of immobilization, criteria for strains and carriers, and optimization of process parameters) as the most efficient approach for stabilizing biocatalysts [17].

Sheldon published the review "Biocatalysis in a Bio-Based Economy". This review is focused on the use of carrier-free immobilization as cross-linked enzyme aggregates (CLEAs). Methods for optimizing this system such as adding proteic feeders to promote cross-linking, and strategies for making the pores accessible for macromolecular substrates, co-immobilization of two or more enzymes in combi-CLEAs or the use of "smart" magnetic CLEAs, are described [18].

The large quantity and diversity in the published articles shows the great interest in the design and development of biocatalysts for the chemical industry.

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