REVIEW

J. Indian Chem. Soc.,
Vol. 97, No. 9b, September 2020, pp. 1-7

A short review on biocatalysis: Sustainable protocol in synthetic chemistry

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Manuscript received online 09 July 2020, accepted 25 August 2020

Amazing advancement and development of molecular biology and biotechnology has opened up new avenues in synthetic chemistry where biological systems can be efficiently mimicked in laboratory and intra as well as extra cellular enzymatic catalysis can be utilized in chemical transformations. Apart from known natural biological protocols modern day protein engineering enabled chemists to design artificial enzymatic reactions to efficiently suit predefined features of a reaction. Use of preferential solvents, substrate, reaction-container and reaction condition can further enhance the width and depth of biocatalysis application. Utilization of nanotechnology in tandem with catalyst immobilization helps in improving catalyst efficacy and reusability of such catalysts. More attempts are being successfully carried out to apply this greener technology in industrial procedures towards sustainable growth.

Keywords: Green chemistry, atom economy, biocatalysis, non-conventional solvent, substrate engineering, cascade reaction.

Introduction

The span of biocatalytic conversion[1] in chemical synthesis is very broad, and it is usually classified between two different patterns.

The primarily available category is incubation mediated whole-cell biotransformation where the starting material acts as the reactant source as well as the multiplication medium of the micro-organism. As a consequence the synthetic utility is obviously dependent on the multiplication rate of the micro-organisms.

The second type of biocatalytic processes are those in which the synthesis of the biocatalyst (major contribution is enzyme) is carried out prior to the synthetic application.

Fermentation protocol had been historically used as a bio-catalyst for facilitating functional material[2] synthesis by natural conversion. Such materials' list includes industrially important materials like ethanol, glycerol, hydracrylic acid[3], lactic acid, pyruvic acid and many others. In recent times successful attempts are being reported for utilization of fermentation for itaconic acid and adipic acid[4] synthetic protocols.

The latest protocols are usually being designed to differentiate the cell growth and cell application steps as often the reaction medium capable of bringing the organic reactant molecules together stands not so favorable for smooth and rapid biotic growth of the desired micro-organism. According to the basic concept of catalysis the cells are supposed to remain alive after the extraction of the target product so that the cells can be reused to make the process cost-effective but it is scarcely achievable due to toxicity in the medium due to presence of different chemical constituents[5]. Moreover, all living cells contain multiple enzymes among which a few can promote unwanted parallel reactions causing decomposition of reactants as well as products to result in lower yield of the targeted molecule. It is also observed that the whole cell biocatalysis loses efficacy in case of bulkier substrates due to poor permeability of the sterically demanding substrate through cell LPL layer[6].

Isolated enzyme biocatalysis is the synthetic protocol where the optimum enzyme is extracted from the biotic organism and purified before the catalytic application. As the catalyst is isolated before the catalytic application the substrate scope increases many fold. Those reactions where the enzymatic catalysis was initially avoided due to lower permeability of the substrates can now be brought under the purview of biocatalysis. But as the cost of catalyst is effec-