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Engineering and Application of Enzymes for Lipid Modification, an Update

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Abstract

This review first provides a brief introduction into the most important tools and strategies for protein engineering (i.e. directed evolution and rational protein design combined with high-throughput screening methods) followed by examples from literature, in which enzymes have been optimized for biocatalytic applications. This covers engineered lipases with altered fatty acid chain length selectivity, fatty acid specificity and improved performance in esterification reactions. Furthermore, recent achievements reported for phospholipases, lipoxygenases, P450 monooxygenases, decarboxylating enzymes, fatty acid hydratases and the use of enzymes in cascade reactions are treated.

Keywords

Biocatalysis, lipase, lipid modification, phospholipase, P450 monooxygenase, protein engineering

1. Introduction

Development of sustainable energy and material production processes is one of the major challenges faced in the prosecution of a more eco-friendly chemical industry. In order to overcome these environmental concerns, the application of greener reaction technologies, as well as the use of renewable raw material sources, is needed to cover the increasing demand of fuels and chemicals as well as to provide compounds for healthy human nutrition. In this sense, the use of vegetable oils – and to a smaller extent of animal fats – together with the implementation of biotechnological methodologies, is an important alternative to traditional petrol derived processes.

Lipid biotechnology employs whole (engineered) microorganisms or isolated enzymes as biocatalysts to obtain a great variety of specialties, which are used for the production of healthy fats and oils, cosmetics, lubricants, coatings, surfactants, biofuels, and many other useful products [1-3]. Commonly used enzymes for the modification of lipids, fats and oils, include mostly lipases, but also phospholipases,