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Perspectives on Biocatalysis

Stefano Curcio*

Department of Engineering Modeling, University of Calabria, Ponte P. Bucci, cubo 39/c, Rende (CS), Italy

With their numerous and various biological functions and activities, natural products, derived from all life forms, have represented a continuous impulse for scientists from several disciplines, including biology, biophysics, biochemistry, chemistry, microbiology, bioinformatics and engineering. The study of the molecules contained in natural products has led to the identification of novel drug targets, to the development of new synthetic and biosynthetic processes, to the engineering of enzymes as biocatalysts and of novel bio-catalytic processes, as well as to the improvement of new computational methods. During the past decade there has been a growing interest in the use of biocatalysts for the high-selectivity conversion of synthetic or natural materials into higher-value products. Most of the early works on biocatalysis actually focused on the use of readily available enzymes, such as esterases, proteases and lipases, which have been progressively exploited for the synthesis of pharmaceuticals, agrochemicals, vitamins, and flavors. The use of enzymes as biocatalysts to replace existing chemical processes or to design alternative approaches to produce chemicals is currently one of the most important technologies in the field of the so-called white biotechnology. Several advantageous characteristics have contributed to the development of bio-catalytic processes. Relatively mild reaction conditions (moderate temperature and atmospheric pressure) are indeed adequate to run enzyme-catalyzed reactions; this lessens the energy requirements and minimizes the problems of isomerization and rearrangement afflicting the corresponding chemical reactions. In addition, environmental safety and cleanliness deriving from the use of low salt, of low metal and limited solvent conditions, of low amounts of acid or alkaline compounds, together with decreased by-product formation, contribute to environmentally friendly processes. Finally, the selectivity and, in particular, the stereochemical properties observed when a biocatalyst operates on its natural substrate is likely to find use in the preparation of several high-value products. A broad array of new methodologies allowed biocatalysis achieving noteworthy progresses in different fields, which ranged from the discovery of novel biocatalysts, to the development of improved biocatalytic processes. Recent advances in biocatalysis are oriented towards the search either of efficient and versatile biocatalysts, able to catalyse reactions that are difficult to perform by traditional chemical methods, or to the modification/optimization of existing biocatalysts by molecular biology. In this context, new and effective approaches like protein engineering, based on rational design or random mutagenesis, as well as adaptation of various enzymes for functioning in novel solvents, enormously expand the limits of biocatalytic applications. Therefore, in addition to the traditional uses of enzymes in food processing, metabolite analysis or organic synthesis, new areas such as the utilization of enzymes in bioremediation or in the formulation of second-generation biofuels are rapidly developing. In particular, the obtainment of second-generation biofuels by biocatalytic processes has come into the focus of research because of the greatly increasing energy demand and of the instability of oil prices.

This issue of the Journal of Bioprocessing & Biotechniques offers readers articles prepared by prominent specialists from various countries. The articles deal with several applications of enzyme or, more generally, with the characterization of processes aimed at the obtainment of specific products from a natural source.

In particular, Rodríguez Fernández et al. performed an experimental study on the leaching of Polygalacturonase produced by a strain of *Aspergillus niger* by Solid State Fermentation of citrus dried pulp. It was showed that the proposed technique may represent a fundamental step of a complete strategy aimed at applying Polygalacturonase in juice clarification. Lee et al. demonstrated that herbal tea prepared by decoction preparation, i.e. the process of extracting medicinal components from the herbs by boiling them in water, has only a low amount of the original toxic heavy metals contained in the herbs. This result suggests that drinking herbal tea is a much safer way of taking beneficial nutrients from the herbs as compared with consuming the whole herbs. Tiwary and Gupta discussed a process for feather meal production from chicken feather by enzymatic degradation performed by Dimeric keratinase from *Bacillus licheniformis* ER-15. The so-obtained feather meal contained 14% nitrogen, 44% carbon with all essential amino acids and showed 73% *in-vitro* digestibility. Coriolus versicolor polysaccharide has been widely studied as a medicinal fungus because of its anti-tumor, antioxidant and immunity improving activities. Wang et al. optimized, by two different methods, the submerged culture conditions for mycelial growth and exopolysaccharides yield with Coriolus versiolor. Carotene desaturation, an essential step in the carotenoid biosynthesis pathway, is catalyzed by two enzymes, phytoene desaturase and ζ-carotene desaturase. González Villa et al. described in their paper the cloning and *Escherichia coli* expression of a novel *Ficus Carica* ζ-carotene desaturase catalyzing dehydrogenation of ζ-carotene into neurosporene and, finally, lycopene. Dussán and Numpaque isolated, from an open cast coal mine, different bacterial strains belonging to *Pseudomonas* sp and *Pseudomonas stutzeri*. The authors demonstrated the ability of the selected strains to degrade the second component of Ammonium Nitrate Fuel Oil (ANFO); moreover, the exploited bacteria demonstrated to represent suitable candidates for diesel bioremediation since they were resistant to diesel compounds.

The contributions in this issue of the Journal of Bioprocessing & Biotechniques demonstrate that both the exploitation of biocatalysis and the rigorous characterization of proper technologies for the utilization of natural resources are crucial to make a reality the transition to green chemistry, which has to be aimed at designing products and processes that minimize the use and the generation of hazardous substances.

***Corresponding author:** Stefano Curcio, Department of Engineering Modeling, University of Calabria, Ponte P. Bucci, cubo 39/c, Rende (CS), Italy, E-mail: stefano.curcio@unical.it

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