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Editorial

Special Issue on Environmental Biocatalysis

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Biocatalysis has developed new molecular tools for the improvement of a wide range of bioprocesses that diminish raw material and energy consumption, while reducing or eliminating the formation of byproducts that might be hazardous to human health and the environment. New advances in the field of biocatalysis apply in the environmental sector, where microorganisms or their enzymes could be used for waste valorization towards the production of high added value products or even the mineralization of xenobiotics. Today, such processes have been advanced due to the improvement in omics technologies and synthetic biology, which provide an enormous amount of data for genome and metagenome mining, as well as the creation of efficient artificial pathways. Novel enzymatic activities may have unique characteristics for the degradation of pollutants, as well as high chemo-, regio- and stereo-selectivity for the modification of aromatic and/or halogenated compounds. This Special Issue aims to highlight the dual potential of novel biocatalytic processes, where the first part is dedicated to waste valorization for the production of high value products, while the second part is focused on the detoxification of pollutants [1–8]. Several examples of microbial systems employed for the valorization of waste streams derived by the forest, agricultural and food industries [1–4], or the use of whole-cell or enzyme approaches for the removal of nitrogen or dyes from industrial wastewaters [6–8], were indicated. Last but not least, an example of the utilization of polyhydroxyalkanoates (PHAs) was highlighted for the production of fatty acids, which were used for the enzymatic synthesis of sugar esters with antimicrobial properties [5].

Starting with the use of biocatalysis for the valorization of waste byproducts towards high added value compounds, Karnaouri et al. utilized residual forest biomass for the sustainable production of prebiotic cellobiose and other cellulose-derived oligosaccharides. For this purpose, a fine-tuning of the performance of the commercially available enzyme mixture Celluclast® was conducted towards the optimization of cellobiose production [1]. Under the same idea, Koutrotsios et al. evaluated olive-mill wastes and olive pruning residues as substrates for the cultivation of *Ganoderma lucidum* and *Pleurotus ostreatus*. Both mushrooms exhibited prebiotic properties supporting or even enhancing the growth of both *Lactobacillus acidophilus* and *L. gasseri* bacteria [2]. Lage et al. employed four Nordic green microalgal strains, namely, *Chlorella sorokiniana*, *Chlorella saccharophila*, *Chlorella vulgaris*, and *Coelastrella*, for the valorization of wood hydrolysates (Silver birch, L. *Betula pendula*) and dairy effluent mixture towards lipid production. Culturing microalgae in integrated waste streams under mixotrophic growth regimes was found to be a promising approach for sustainable biofuel production, especially in regions with large seasonal variation in daylight, like northern Sweden [3]. Waste cooking oil, a major pollutant from the food industry, was used as a resource for the high cell density bioprocess for PHA production. The presented bioprocess reached a 33-fold higher PHA productivity compared to previous reports using saponified palm oil, representing an excellent basis for the industrial conversion of waste cooking oil into PHA [4]. In addition to the production of PHA from food waste, Snoch et al. utilized such PHA polyesters for the enzymatic synthesis of sugar esters. With the aid of enzyme biocatalysis, a series of glucose esters were created with unmodified and modified PHA monomers, showing moderate antimicrobial activity [5].

In the second part of the Special Issue, biocatalysis was used as a tool for the treatment of industrial wastewater pollutants. Dolejš et al. studied the co-immobilization of anammox and ammonia-oxidizing bacteria into a polyvinyl alcohol hydrogel, and its effective use in nitrogen removal. This is the first report of such immobilization strategy to indicate that pH-stat and substrate limitation stimulate the co-immobilized bacteria activity in biotransformations [6]. Another form of waste that was considered in this Special Issue was dye-containing wastewater, which presents an increasing global issue due to the increase in population and demand for clothes and other colored products. To tackle this problem, Lončar et al. used genome sequence information to discover dye-decolorizing peroxidases from *Pseudomonas fluorescens* Pf-01, reporting for the first-time the peroxidase-catalyzed insertion of a carbene into an N–H bond [7]. Enzymatic biocatalysis was also employed for the degradation of a broad series of dyes, proving its potential for the treatment of textile industrial wastewater. In particular, Mandic et al. discovered novel laccases combining different approaches including DNA sequence analysis, N-terminal protein sequencing, and genome sequencing data analysis for laccase amplification, cloning, and overexpression. Four active recombinant laccases were obtained from different *Pseudomonas putida* species, highlighting the potential of this genus as a good source of biocatalytically relevant enzymes [8].

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