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Editorial

Enzyme Catalysis: Advances, Techniques, and Outlooks

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Biocatalysis using enzymes is a powerful strategy that can be employed in a variety of industries for the production of biofuel, biochemicals, pharmaceuticals, and foods, etc. [1]. Compared with the chemical method, enzyme catalyst is considered as an eco-friendly and more selective tool, facilitating a sustainable and circular economy. Enzymes possessing high catalytic efficiency, stability to harsh conditions (i.e., heat, extreme pH, and high salinity), and desired substrate specificity are considered to be process-compatible. To discover such robust enzymes, various technologies of bioinformatics, machine learning, protein engineering, and high-throughput screening (HTS) have been developed [2]. With the aid of those cutting edge technologies, it is more readily achievable to discover and develop novel and superior enzymes. Noteworthy, Frances Arnold's award of the Nobel Prize in 2018 for protein engineering facilitates the scaled-up applications of enzyme in industries.

This Special Issue "Enzyme Catalysis: Advances, Techniques, and Outlooks" aimed to contribute to the advancement of related fields by covering broad subjects and technological developments on industrially relevant enzymes, such as sugar isomerase (i.e., gluose/fucose isomerase, lysozyme, protease, and cytochrome P450. Under this Special Issue, a total of six papers were published, comprising five original research papers and one review paper.

Cytochrome P450 is considered as industrially useful biocatalyst due to its versatility [3]. Nguyen et al. reported an efficient enzymatic strategy using bacterial CYP102A1 peroxidase for the synthesis of 4-OH atorvastatin from atorvastatin, which is the key human metabolite having a beneficial effect on cardiovascular disease and hyperlipidemia [4]. Specifically, a superior mutant of CYP102A1 was obtained with a catalytic efficiency of 1.8 min^{-1} with an aid of HTS and enzyme characterization. This approach was conducted in the presence of hydrogen peroxide but without NADPH, which was further discussed on its advantage over NADPH-requiring monooxygenase.

The Michaelis–Menten equation is routinely used for the investigation of enzyme kinetics. However, when the reaction product acts as the inhibitor, this conventional model does not necessarily reflect the enzyme's actual behaviors, causing a misinterpretation. For reliability, Fernandes et al. developed a robust methodology based on an integrated Michaelis–Menten equation (IMME) [5], which could be helpful for the investigation of enzymes such as the well-known β-glucosidase, often encountering end-product inhibition (i.e., glucose) [6].

Zhang et al. developed a more efficient detergent than commercial ones by preparing for in-house blends composed of different proteases (i.e., alkaline protease, keratinase, and trypsin) combined with detergent additives including surfactants, anti-redeposition agents, and water-softening agents [7]. During the process, various approaches, such as whiteness determination, microscope scanning, Fourier transform infrared spectroscopy, and X-ray photoelectron spectroscopy were used to assess the cleaning efficiency.

Sugar isomerase is a class of enzymes that mediate the interconversion of sugar isomers in a reversible manner. With its broad substrate scope, this enzyme has wide applications in food/beverage, pharmaceutical/medicinal, and beauty industries [8].

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The well-recognized glucose isomerase (GI), which is involved in catalyzing the reaction between D-glucose and D-fructose, and D-xylose and D-xylulose has already been commercially available for the production of high-fructose corn syrup. Recognizing the significant role of the enzyme both in academic and industrial sectors, Nam presented an overview of the functions, structure, and applications of GI with a focus on structural insight into the metal-binding site and interaction with the inhibitor [9].

Extremozymes are capable of maintaining their functions even in harsh conditions, such as high temperature/salinity and extreme pH levels, and are thus considered desirable for industrial application. In this regard, Kim et al. reported a unique L-fucose isomerase from the polyextremophile *Halothermothrix orenii* (HoFucI) that exhibits both halo- and thermophilicities when synthesizing L-fucose from L-fuculose. Such a robustness offers a great advantage for the L-fucose isomerase-mediated production of rare sugars [10].

Lysozyme, a glycoside hydrolase that breaks down the peptidoglycan, the major cell wall component of microorganisms, is a natural antimicrobial agent. Nam reported three forms of crystal structure of human lysozyme: one native and two *N*-acetyl-α-D-glucosamine-complexed configurations, providing an insight into the mechanism by which lysozyme recognizes sugar molecules when involved in the immune responses to microbial infections [11].

Overall, this Special Issue detailed wide applications of industrially useful enzymes with excellent experimental data and improved their methodology in addition to providing state-of-the art reviews on their technological advances. I, as the guest editor, am sincerely grateful for all the efforts from the authors, reviewers, editors, and staff of the editorial office of Applied Sciences for their work in successfully completing this Special Issue.

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Short Biography of Author

Dr. In Jung Kim performed her Ph.D. research in Food Bioscience and Technology at the University of Korea in South Korea (2008–2014) on a project about enzymatic saccharification of lignocellulosic biomass. After a 5-year postdoctoral research at the University of Korea (2015–2019) on a project about biosynthesis of rare sugars and their source, she did her overseas postdoctoral research in at the University of Greifswald in Germany (2020–2021) to perform the project on biotechnological production of aroma compounds. Currently, she is a research professor at Kyungpook National University in Korea.