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Editorial

Editorial on Special Issue "Biorefinery: Current Status, Challenges, and New Strategies"

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The overdependence on fossil fuels has raised concerns about global warming and the energy crisis, which has warranted significant research to find alternatives. Lignocellulosic biomass has attracted significant attention because it is renewable, abundant, and carbon-neutral [1]. The past decade has seen increasing research efforts to develop biomass-to-bioproducts processes. Despite the huge potential proven by recent biorefineries, the current bioeconomy still faces various technical challenges. In this respect, modern lignocellulosic biorefineries aim to develop more sustainable biomass conversion processes, tackling such challenges.

Fractionation of biomass components, typically the first stage in biomass conversion processes, remains an essential step to facilitate the separation of lignin and polysaccharides. In this Special Issue, Ahmed et al. [2] studied the effect of gamma-valerolactone (GVL)-assisted biomass fractionation on lignin extraction and cellulose digestion. GVL was recently viewed as a sustainable alternative in biomass defragmentation [3]. In this article, the authors reported that 80% aqueous GVL could effectively remove lignin and enhance enzymatic digestibility. Lee et al. [4] used a two-step pretreatment approach that includes an acid-catalyzed steam explosion followed by alkali-catalyzed organosolv treatment to separate cellulose-rich fraction and lignin from an empty fruit bunch.

In addition to the fractionation methods, this Special Issue covers various bio-products that can be produced from lignocellulosic biomass. For example, Kim et al. [5] explored a simultaneous conversion and extraction of furfural from hydrolysates using an aqueous biphasic system. They specifically focused on converting pentoses found in dilute acid hydrolysates into furfural, and the maximum yield of furfural was up to 94.6%. Jang et al. [6] presented the autohydrolysis of sweet sorghum bagasse to produce fermentable sugars and xylooligosaccharides (XOSs). Considering that the application areas of XOSs continue to expand, the production of XOSs from non-edible sources (i.e., lignocellulosic biomass) would be highly promising. Cho et al. [7] reported the catalytic conversion of α-pinene into high-density fuel candidates over stannic chloride molten salt hydrates ($SnCl_4 \cdot 5H_2O$), suggesting reaction mechanisms. Su et al. [8] summarized current metabolic engineering strategies that have been applied to biomass-to-isobutanol conversion processes. They also introduced recent advances in the production of isobutanol from various biomass feedstocks.

Biomass characterization is also an important area of modern biorefineries. Recently, diverse biomass processings, including chemical, thermal, biological, and hybrid processes, have been developed. It requires an in-depth characterization of biomass, understanding how those processes affect biomass structure and properties. Zhuang et al. [9] systematically used Fourier transform infrared (FTIR) analysis to characterize different types of biomass and their products. They successfully identified contaminants on the biomass surface. The information obtained from this study could help to prevent misunderstanding the FTIR analysis results of the processes biomass. Koo et al. [10] studied the drying effect of enzymatic hydrolysis of cellulose. They adopted the drying effect index (DEI), determined by analysis of porosity and crystallinity, to evaluate the effect of drying on the following processing. It was found that the drying effect was correlated with cellulose porosity, mainly due to the fiber hornification.

In recent biorefineries, there has been a shift from perceiving lignin as waste to viewing lignin as a potential material for value-added produces. Considerable efforts have been made to develop lignin conversion processes to produce specialty chemicals and polymeric materials to replace petroleum-based ones. More recently, attention has been placed in sectors, including the medical, electrochemical, and polymer sector, where lignin can be valorized. Yu and Kim wrote a review covering the recent research progress in lignin valorization, specifically focusing on medical, electrochemical, and 3D printing applications with technoeconomic insights [11].

Lastly, Harahap et al. [12] presented interesting research on technoeconomic evaluation of hand sanitizer production using oil palm empty fruit bunch (OPEFB)-based bioethanol. The COVID-19 pandemic increased the demand for ethanol as the primary ingredient of hand sanitizers. In this article, they evaluated the technoeconomic feasibility of hand sanitizer production using bioethanol produced from OPEFB. The results clearly suggest that the production of hand sanitizer from bioethanol is economically viable and can be implemented at a tolerable price as an alternative application for second-generation bioethanol.

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