บรรณาธิการปริทัศน์/Editorial Corner

การผลิตสารเคมีแพลตฟอร์มจากกระบวนการกลั่นทางชีวภาพของชีวมวลลิกโนเซลลูโลสและความสำคัญต่อภาวะโลกร้อนและเป้าหมายการพัฒนาอย่างยั่งยืน
Production of Platform Chemicals from Biorefining Process of Lignocellulose Biomass and its Significance to Global Warming and Sustainable Development Goal

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ศูนย์วิศวกรรมโรงกลั่นชีวภาพและกระบวนการอัตโนมัติ สาขาวิชาวิศวกรรมเคมีและกระบวนการ บัณฑิตวิทยาลัยวิศวกรรมศาสตร์นานาชาติสิรินธร ไทย-เยอรมัน มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ

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The world is facing an unprecedented environmental crisis, with increased emissions of greenhouse gases that have led to a rapid and steady increase in global temperatures and climate change, which in turn is causing catastrophic events all over the world [1]. In order to combat this issue, it is crucial to produce more sustainable and eco-friendly sources of energy and materials. Another important aspect of this approach is that it can help to achieve the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 12 (Responsible Consumption and Production). Renewable energy technologies must develop significantly more quickly in order to achieve the SDGs, and steps must also be taken to provide a fossil fuel exit strategy [2]. This motivates scientists to create efficient energy produced from sustainable sources that will support society in the long term.

One promising solution to this problem is the production of platform chemicals from the biorefining process of lignocellulose biomass [3]. A biorefinery can be considered to be an integral unit that can accept several biological nonfood feedstocks and can process them into a variety of valuable outputs like chemicals, energy, and materials. Biomass, a sustainable source of carbon, is guaranteed a place in the new energy portfolio

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in order to replace the fossil-based product for the foreseeable future. Lignocellulose biomass is the most abundant and widely available biomass, including agricultural wastes, forest residues and woody materials. The complex cross-linked structure of lignocellulose biomass is composed of three main components: cellulose, hemicellulose, and lignin. The recalcitrant nature of biomass such as the crystallinity of cellulose, degree of polymerization of lignin, pore size and pore volume hinder the direct conversion into products. It can be broken down and processed through a biorefining process to produce a wide range of valuable chemicals, including platform chemicals such as sugars and aromatics [4].

Platform chemicals are building block chemicals or small molecule chemicals, which are readily converted or reacted to chemical intermediates to form final biochemical products. These chemicals are targeted not only for producing biofuels but also for various downstream industrial products [5]. One of the key benefits of producing platform chemicals from lignocellulose biomass is that it can significantly reduce our dependence on fossil fuels. The use of biofuels, for example, can significantly reduce the number of carbon emissions associated with the transportation sector, which is one of the major contributors to global warming. Additionally, the production of bioplastics can help to reduce the use of traditional plastics, which are non-biodegradable and contribute to pollution and waste [6].

The biorefining process involves mainly three significant steps for the conversion of the components of lignocellulose biomass to platform chemicals. The preliminary step is the pretreatment of the biomass where the dissociation of the complex structure of the lignocellulose into its components occurs and makes the cellulose, hemicellulose and lignin more accessible for further conversion. The most common methods of pretreatment include physical, chemical, and biological methods, such as acid hydrolysis, steam explosion, organosolv, ionic liquids, deep eutectic solvents, etc [7]. The next step called saccharification where the important platform chemical which is simple sugars like glucose and xylose formed due to the breakdown of cellulose and hemicellulose with the action of enzymes. Additionally, lignin components can also be converted into platform chemicals such as vanillin and phenol through a process called lignin depolymerization. This process involves the use of chemical or biological methods to break down the lignin into smaller molecules that can be used as feedstocks for the production of chemicals and materials. Finally, the sugars produced through saccharification are subjected to the fermentation step for the valorization of the platform chemicals such as biofuels, bioplastics, and other bio-based chemicals [8].

Overall, the biorefining process of lignocellulose to convert it into platform chemicals is a complex and multi-step process that faces several challenges. For instance, current pretreatment methods can be expensive, energy-intensive, and generate significant amounts of waste. Additionally, some processes can cause damage to the cellulose and hemicellulose resulting in the reduction of platform chemical yields and low solid recovery rates [9]. In enzymatic hydrolysis, the cost of enzymes is high and the efficiency of hydrolysis can be low due to the complexity of the lignocellulose structure. Moreover, lignin is a complex and highly cross-linked polymer that is difficult to break down. The development of efficient and cost-effective methods for lignin depolymerization is still an ongoing research area.

Another challenge includes the availability of lignocellulose biomass, the logistics of collecting, and transportation. Biomass is often dispersed and difficult to collect in large quantities. Furthermore, the transportation cost can be high. The production of platform chemicals from lignocellulose biomass results in a complex mixture of products that need to be separated and purified. This step can be energy-intensive and add to the overall cost of the process. Many of the biorefining processes for lignocellulose have been developed and tested at a laboratory or pilot scale, scaling up these processes to a commercial level can be challenging.

Despite these challenges, research and development in biorefining technology continue to progress, and new technologies and methodologies are being developed to overcome these obstacles. The development of efficient and cost-effective biorefining processes is crucial to making the conversion of lignocellulose into platform chemicals a viable and sustainable option. However, it is important to note that the development and implementation of biorefining technologies are still in the early stages and there is still room for improvement. Extensive research is ongoing to reduce the high costs associated with pretreatment and saccharification by combinatorial studies of two or more methods [10], [11].

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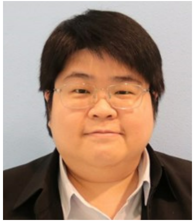

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