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EDITORIAL

Editorial for BCAB Special Issue "Lignocellulosic biorefinery"

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Lignocellulose is the most abundant raw material for 2nd-generation biorefinery. Although it is a potential source for a variety of platform chemicals, lignocellulose provides a number of challenges in terms of logistic, mechanical, and chemical pretreatment—the principal fractionation or transformation process and subsequent separation processes. Many researchers have tried to overcome these challenges over the past few decades, and tons of research has been devoted to these topics. The main goal thereby is a full conversion of lignocellulosic material into valuable products, analogous to the oil refinery process. Despite extensive research, this overarching goal has still not been fully achieved. We require a deeper understanding of each individual step in the process, as well as a new, realistic, innovative concept to combine them in order to provide the product streams in the quantity and quality adequate for specific applications.

Herein, a fundamental question arises regarding the effectiveness of the fractionation and transformation approach: should the structure of the molecules present in the biomass be preserved as much as possible, essentially resulting in subsequent complex separation processes? Or should the largest fraction streams be converted into low molecular platform chemicals for further synthesis using existing chemical technologies? Till now, no general answer to this question has been formulated. However, more and more authors have adopted an application-oriented approach, suggesting that the quality of given product streams required for specific products does not necessitate highest purities or standardized compositions for the corresponding final applications. From this point of view, the requirements of the application should define the quality of the product stream rather than vice versa, where new applications are being searched in order to utilize a resulting product stream. Consequently, the challenge is to tune and to optimize the corresponding pretreatment, hydrolysis, and separation steps simultaneously, so that each stream achieves the application requirements.

In this Thematic Issue, research on both approaches of, firstly, the conversion to low molecular weight products (methane, syngas, biogas) and, secondly, the production of high molecular weight components with retained original structure (lignin, polysaccharides) will be presented.

The use of unmodified lignin, yielded from lignocellulosic biomass, is suggested in the papers of Gil et al., Conrad et al., and Hu et al., assessing the possible use of high-quality lignin for food and pharmaceutical products. These papers particularly address the high-priced application segment of lignin and provide a perspective to make the biorefinery process collectively more economically feasible. Hu et al. suggest to use unmodified lignin in adhesive tapes, both as fillers and as antioxidant component. Here, experimental trials are performed in collaboration between academia and industry. This way, emphasis was put on application requirements. In their study, lignin is produced from wheat straw using hydrothermal pretreatment and subsequent enzymatic hydrolysis. This process is further addressed and optimized in the paper of Conrad et al. Here, C5 and C6 hydrolysates are produced as further streams besides the solid lignin fraction, which also needs to be accounted for in the assessment of the total economic feasibility. Further, production of fermentable sugar streams is tackled in the contribution of Mendezarias et al. using fibers of empty fruit bunches from oil palms as raw material, whereas Gröngröft et al. present a holistic biorefinery approach based on woody biomass, generating besides lignin a number of platform and fine chemicals (e.g., maleic acid). In this approach, lignin itself can be further depolymerized to smaller oligomers or further low-weight molecules.

The second approach—biomass conversion to small(er) molecules—is followed in other papers of this thematic issue. One of the approaches is catalytic pyrolysis of lignocellulose to obtain high-value bio-oil. Schmid et al. discuss their experience in thermochemical gasification of lignocellulose (and residues) for producing a gas to be used

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subsequently for heat and power production, or, after several cleaning steps, for the synthesis of selected chemicals. Explicitly, Fischer–Tropsch synthesis of biomass-derived syngas is described by Gruber et al. All contributions stress the point that the quality of the provided syngas is strictly related to the following synthesis procedure.

Overall, this thematic issue gives an insight into a variety of methods to convert lignocellulosic materials into a number of products and shows significant progress in the corresponding technical processes. Lastly, a majority of these papers discuss not only the principal potential of their respective processes, but also their techno-economic analysis. This is an essential building block in biorefinery research, which highlights the need for interdisciplinary teams being involved in this evaluation.

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