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Plant Wastes for High-Value Chemicals

A new technology that has the potential to significantly improve the way plant material is valorized has recently been developed at EPFL in the lab where I did my master thesis[1][2]. Indeed, for the first time this groundbreaking technology allows to tackle the problem of so-called "lignin-rich" feedstocks.

Plant dry matter is mainly composed of 3 biopolymers: cellulose, hemicellulose and lignin. If methods to convert cellulose and hemicellulose have been implemented, lignin remains widely unexploited while she represents 15 to 30 wt%. of the starting material. This stems from the challenge of extracting it from lignocellulosic biomass without degradations. The technology mentioned previously uses protection group to avoid any degradation. A depolymerization is then applied on the extracted material to produce high-value low-molecular-weight chemicals that are usually tapped from oil. Those molecules are used in the chemical industry for various applications.

The extraction protocol was developed on wood, but other feedstocks present high lignin content and could therefore be treated with this method. The goal of this project is to evaluate if agricultural wastes could be valorized thanks to this technology. Indeed, due to their slow decomposition rate, lignin-rich waste accumulates in countries that lack the infrastructure to treat it properly. As a consequence, this valuable material is largely burnt in the Global South. One good example of this phenomenon is the coconut coir in India. Coconut culture generates a huge volume of Biomass (more than 11 millions tons produced in India in 2016 according to the FAO). This production generates wastes that represent a large burden for producers, who pile them up before burning them next to the fields.

In order to carry out the project, I will investigate the abundance of lignin-rich feedstock in developing countries and determine which is causing the largest impact on the environment. Then I would like to design a strategy to convert it to valuable products for the chemical industry. In other words, the goal of the project is to apply the technology developed initially for wood by EPFL to Global South plant wastes so that they can be valorized instead of being burned. In addition to generating profits, the goal of this project is to reduce the greenhouse gases emitted by the combustion of these feedstocks, promote sustainable industrialization in countries with lignin rich plant wastes, ensure a sustainable ecosystem by avoiding areas to be burnt, improve health conditions in affected areas and reduce inequalities by providing additional income to farmers

In concrete terms, the project will take place in three stages. The first will be the identification and evaluation of lignin-rich feedstock. The objective of the second part of the project will be to select the most promising feedstock in terms of social impact and yield during the valuation. In the last step, the valuation process will be optimized for the selected feedstock.

References

[1] Shuai et al., *Science*, vol. **354**, num. 6310, p. 329-333, 2016
[2] Lan et al*., Angew Chem*, vol. **57**, num. 5, p. 1356-1360, 2018