Waste plant materials remaining from palm oil extraction processes can now be converted into a useful sugar

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After the extraction of oil from the oil palm plant, the remaining plant matter (above) can be converted into useful chemicals, including xylose. Credit: 2012 A*STAR Institute of Chemical & Engineering Sciences

Palm oil extraction annually produces approximately 13 million tons of waste plant matter. Some of this by-product, known as empty fruit bunch (EFB), is currently incinerated to produce heat and electricity to run palm oil mills, but it is now on the path to a sweeter use. By adapting and optimizing an established technique to convert sugarcane bagasse and corn stover to the useful sugar xylose, a research team in Singapore, led by Jin Chuan Wu from the A*STAR Institute of Chemical and

Engineering Sciences, has experimentally extracted high yields of xylose from EFB.

EFB contains xylan, which is a carbohydrate made up of units of xylose. Xylan is very susceptible to being broken down to these individual sugar molecules in the presence of mild acid. Known as hydrolysis, this process is not widely applied to EFB—despite its well-established use for converting sugarcane bagasse and corn stover—because of difficulties in making it cost effective. The key to Wu and his team's success was the combination of acids they selected for hydrolyzing EFB: sulfuric (H_2SO_4) and phosphoric acid (H_3PO_4). "The combined use of H_2SO_4 and H_3PO_4 has a synergistic effect in improving sugar yields," explains Wu.

Since the elements sulfur and phosphorus are essential for the fermentation of xylose using microbes, the researchers' combination of acids will play a fundamental role in the further conversion of xylose into other useful chemicals, such as the sugar substitute xylitol, lactic acid and ethanol. After hydrolysis and neutralization, these acid components can be used directly in a microbial fermentation. Hydrolysis requires the levels of these elements to be low, with higher levels being detrimental. In previous EFB hydrolysis techniques, higher concentrations of acids were used, but the levels of sulfur and phosphorous were too high for the microbial fermentation stage.

After discerning the right combination of mild acids, Wu and his team used computer modeling followed by supporting experiments to find the optimal conditions for hydrolysis. They obtained xylose yields of 80–90%. The conditions they optimized included the concentrations of the two acids, the reaction temperature, the dilution of the solution and the size of the EFB particles.

"Next, we will convert the sugars into lactic acids by microbial

fermentation using lactic acid bacteria," explains Wu. This lactic acid will be used for producing polylactic acid: a renewable and completely biodegradable biopolymer, that he says is stable at high temperatures and has broad applications.

More information: Zhang, D., Ong, Y. L., Li, Z. & Wu, J. C. Optimization of dilute acid-catalyzed hydrolysis of oil palm empty fruit bunch for high yield production of xylose. *Chemical Engineering Journal* 181–182, 636–642 (2012). www.sciencedirect.com/science/ … ii/S1385894711015488

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