'One-pot' industrial process for manufacturing high yields of artificial sweetener under mild conditions successful

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Most industrial manufacturing processes involve the use of many different reagents across multiple reactors—an approach that is costly, laborious, time-consuming and environmentally unfriendly. 'One-pot' processes, in contrast, involve putting all the reagents in a single reactor

and fine-tuning conditions to achieve maximum yield.

Xylitol, a popular artificial sweetener that contains 40% less calories than white sugar, has traditionally been manufactured from plant matter through a multi-step process under intense heat in a high-pressure hydrogen environment. Guangshun Yi and Yugen Zhang at the A*STAR Institute of Bioengineering and Nanotechnology in Singapore have now developed a technique that produces xylitol in a single reactor. This one-pot technique avoids the need to separate and purify the intermediate chemical compounds, thereby speeding up the process while using less reactant and increasing chemical yield. The technique also operates under milder conditions than current industrial techniques.

Yi and Zhang's technique depends on two distinct but equally important steps. The first involves using a strong acid to break some of the chemical bonds in xylan, an organic molecule found in the cell walls of plants, to form an intermediate molecule called xylose. In the second step, a ruthenium catalyst, in the presence of isopropanol, changes xylose into xylitol. The catalyst can be re-used many times throughout the manufacturing process, which makes it cost-effective. Although replacing the standard hydrogen environment with isopropanol does have a small negative environmental impact, the overall process, which avoids multiple steps, is more environmentally friendly than current industrial techniques, according to Zhang.

The researchers' reaction achieved a maximum yield of 80% at a temperature of 140 °C, which is relatively mild compared with current industrial techniques for producing xylitol. The presence of a strong acid in the first step of the reaction also proved crucial for achieving a high yield; without it, the yield was a mere 5.7%. The maximum yield of 80% was achieved over a reaction time of 3 hours; increasing this time to 8 hours caused very little difference in yield, but extending the reaction time beyond 8 hours reduced the yield.

Yi and Zhang are confident about the prospects of their new technique, particularly given its advantageous properties of a short reaction time, re-usable catalyst and relatively low reaction temperature. "We are currently in discussion with a company to develop this technology, and are also in the process of testing and optimizing conditions for real industrial samples," Zhang says.

More information: Yi, G. & Zhang, Y. One-pot selective conversion of hemicellulose (xylan) to xylitol under mild conditions. *ChemSusChem* 5, 1383–1387 (2012). onlinelibrary.wiley.com/doi/10 … c.201200290/abstract

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