Using agricultural waste materials to produce lactic acid

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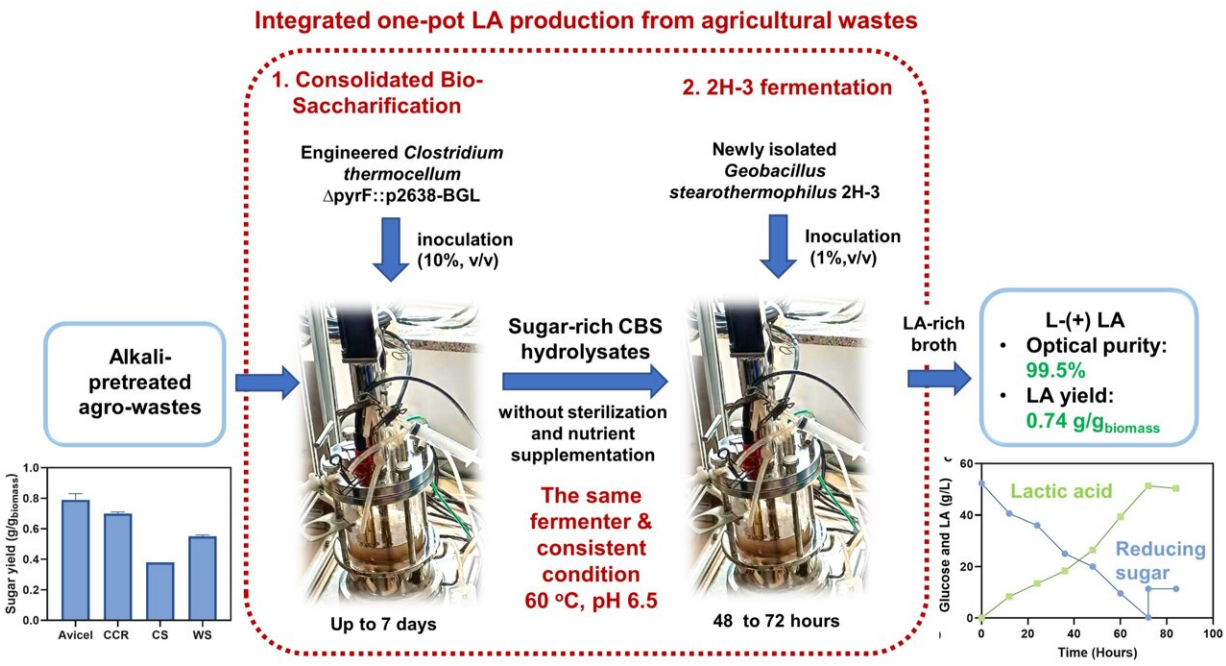

Schematic representation of the integrated LA production process from agro-wastes. Credit: LIU Yajun

Lactic acid (LA) is an important chemical intermediate for a plethora of products, from medicine to cosmetics to degradable materials, and is the building block for biodegradable polylactic acid (PLA), a main component in compostable, recycled plastics.

With a high demand for PLA and lactic acid in general, finding a non-food carbon source for the LA synthesis process is a big step toward developing and implementing more sustainable practices.

Researchers from the Qingdao Institute of Bioenergy and Bioprocess Technology (QIBEBT) of the Chinese Academy of Sciences and their collaborators are streamlining a way to use the abundant agro-waste products in non-food feedstocks to derive LA from lignocellulose, a complex structural network found in the plant cell wall. Using consolidated bio-saccharification (CBS), they were able to take the raw material of lignocellulose and obtain LA through a fermentation process.

The findings were published in *Journal of Environmental Management* on June 6.

Interestingly, the results helped elucidate an efficient lactic acid producer the researchers may not have been aware of: Geobacillus stearothermophilus. Upon observation of contamination in the CBS system, it was determined G. stearothermophilus was a major LA producer and could grow using various sources of sugar as the carbon source. This efficient LA producer combined with the all-included "one-pot" method of CBS can easily yield impressive results from a resource and cost-reducing standpoint.

"Our results emphasize the possibility of industrial-scale production of LA from lignocellulosic feedstocks, as the integration method can reduce the need for intermediate sterilization, nutrient supplementation, or adjustment of fermentation conditions," said Liu Yajun from QIBEBT, first author of the study.

The biggest hang-up so far in using agro-wastes to produce worthwhile end products is the process of breaking down the lignocellulosic biomass into something that has usable sugars for fermentation. Using G.

stearothermophilus in the CBS reaction as the catalyst for sugar production, researchers found it to be a very robust producer of high-quality lactic acid that is able to use multiple carbon sources for saccharification or the production of simple sugars from a more complex sugar.

Being able to produce optically pure, high-quality and high-yield lactic acid using non-food stocks can have positive implications for the world's food supply, as food that is grown for consumption is not also being used to produce lactic acid.

The CBS process isn't confined to producing only lactic acid. It's worth noting that lactic acid production may just be the start; other downstream fermentation products may be able to make further use of the abundance of lignocellulose from various agricultural waste products. By changing the chemicals and species used in the CBS process, more products can be made with a more cost-effective method.

"The CBS technology has been demonstrated to be compatible with various downstream microalgae, yeast, and bacterial fermentation to produce high-value-added chemicals, such as pullulan, with high yield and titer," said CUI Qiu from QIBEBT, corresponding author of the study. "We hope to see the cycle time reduced and the ability to effectively scale up fermentation."

More information: Ya-Jun Liu et al, Integrated lactic acid production from lignocellulosic agricultural wastes under thermal conditions, *Journal of Environmental Management* (2023). DOI: 10.1016/j.jenvman.2023.118281

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