YEAST-BASED ROUTE TO SUCCINIC ACID IS BEST

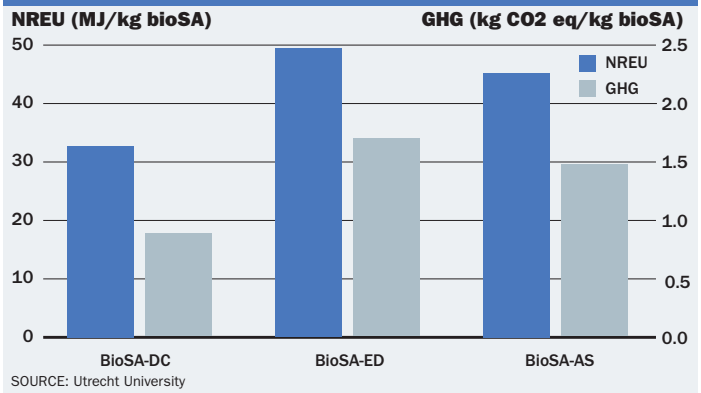
Researchers at the University of Utrecht have shown that a low-pH yeast route to succinic acid has the lowest environmental impact in terms of energy use and carbon emissions

Bio-based succinic acid is starting to attract attention as a versatile renewable raw material in the production of a number of polymers and chemicals, notably 1,4-butanediol, the biodegradable polymer polybutylene succinate (PBS), resins, phthalate-free plasticisers and polyester polyols for polyurethanes.

A handful of companies, including Reverdia, Myriant, BioAmber and BASF/Purac (Succinity) are bringing capacity onstream over the next two to three years. Customers will, of course, need to be convinced not only of the cost and performance credentials of the new material, but also its environmental performance and footprint.

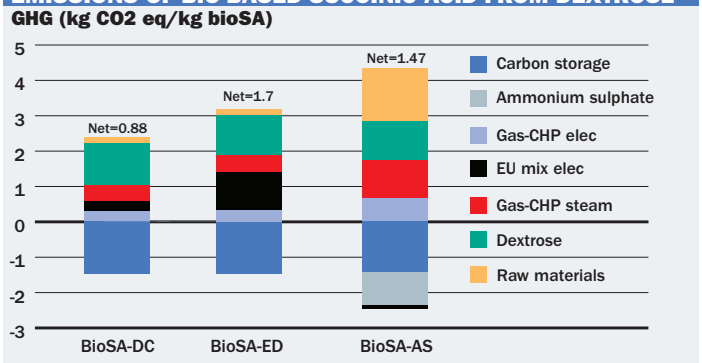
To obtain a quantitative understanding of the eco-friendly performance of bio-succinic acid, a life-cycle assessment (LCA) on various process routes to the material, both bio-based and petrochemical, was carried out.

NREU AND GHG EMISSIONS FOR BIO-BASED SUCCINIC ACID



SOURCE: Utrecht University

BREAKDOWN OF SUB-PROCESS CONTRIBUTIONS FOR GHG EMISSIONS OF BIO-BASED SUCCINIC ACID FROM DEXTROSE



SOURCE: Utrecht University

ISO 14040 STANDARD USED

The study has been carried out following the principles of ISO 14040 on LCA standards by researchers at Utrecht University in the Netherlands and the results made publicly available in a peer-reviewed journal (see footnote).

Three bio-based routes using dextrose from corn were analysed to determine their non-renewable energy use (NREU) and greenhouse gas (GHG) emissions on a cradle-to-factory gate in Europe basis. The study also looked at three petrochemical routes, to maleic anhydride, succinic acid and adipic acid, which can be used as feedstocks for comparable downstream products.

The three bio-based routes considered were: a low pH yeast fermentation with downstream processing by direct crystallisation (bioSA-DC), for which Reverdia has a number of patents; anaerobic bacterial fermentation to succinate salt and neutral pH and subsequent separation by electrodialysis (bioSA-ED); and a similar process producing ammonium sulphate as co-product in the downstream step (bioSA-AS).

The relatively new low pH yeast process is, says Reverdia, expected to result in overall improved economics and environmental footprint. Both are dependent on plant location and the latter also on the way energy – for example gas- or coal-fired combined heat and power, and material inputs and outputs – are allocated in the LCA. The study took these factors into account, as well as looking at which sub-processes in the production chain contributed most to energy use and GHG emissions.

As the base case, the study assessed material made in Europe, based on dextrose produced from corn starch. A sensitivity analysis was made to assess the impact of basing production in China, the US and Brazil, the latter using sugarcane as the raw material.

The report's conclusions do indeed support the belief by Reverdia that its new process has environmental benefits over the petrochemical and also bacteria-based bio-routes. The yeast-based process shows significantly lower NREU and GHG emission levels than the electrodialysis and ammonium sulphate routes.

NREU is 32.7 MJ/kg of bio-succinic acid, compared to 49.4 and 45.2 MJ/kg for the two other routes, and GHG emissions are only 0.88 kg CO2 equivalent/kg bio-succinic acid, compared with 1.70 and 1.47 kg/kg, respectively. These figures take into account the storage of biogenic carbon in the product. The yeast NREU and GHG figures are also significantly lower than for the three petrochemical routes.

Looking at the effect of location, the Utrecht researchers found that the difference in GHG emissions between Reverdia's yeast process and the electrodialysis route become smaller for Brazil and larger for the US and China, a result explained by the difference in emission intensity in each country's electricity production mix.

In conclusion, the LCA study finds that the low pH yeast fermentation process with direct crystallisation has best-in-class performance in terms of NREU (51% and 38%) and climate change (92% and 67%) compared with the alternative bio-based routes via electrodialysis and ammonium sulphate processes, respectively.

Moreover, the NREU and GHG emissions of the yeast process compared with three petrochemical counterparts are a factor of 1.9–3.8 and 2.0–10.0 lower, respectively. ■

For the full study, visit: http://onlinelibrary.wiley.com/doi/10.1002/bbb.1427/abstract