*Advanced Biofuels USA, a nonprofit educational organization, advocates for the adoption of advanced biofuels as an energy security, economic development, military flexibility and climate change solution.*

## Selected bio-based acid producers

*Part of a series of informational summaries related to co-products, precursors, intermediates and biochemicals important to the understanding, development and use of advanced biofuels.*

*By Milsa Vijayadharan*

1. **Lactic Acid**-Lactic acid is mainly used in the food industry for preservation, acidification and flavor enhancement.
    - Purac- At Purac lactic acid is produced as natural L-Lactic acid by fermentation of carbohydrates like sugar or starch. Purac is a leading company in natural food preservation, lactic acid based bioplastics and biobased chemicals with branches all over the world.
    - B&G Lactic- B&G produces L(+) lactic acid by fermentation of a specific non-GMO bacteria directly isolated from natural and using corn glucose as starting raw material. With an annual capacity of 30,000 metric tons, B&G is the largest manufacturer of natural L (+) lactic acid in Asia/Oceania.

2. **Succinic acid-** Succinic acid is used as a raw material for producing polyurethanes, coatings, adhesives, sealants, personal care ingredients and as a preservative in the food industry
    - BioAmber- BioAmber has developed a proprietary process to produce bio-succinic acid sustainably from renewable plant feedstock. The renewable feedstock used by BioAmber for the production of succinic acid includes corn, wheat, cassava, rice, sugarcane, sugar beets and forest waste. The financial results announced by BioAmber for the fourth quarter and year ended December 31, 2013 stated that Bio-succinic acid sales increased by 16% in the year ended December 31, 2013 to $2.7 million, compared to $2.3 million in the year ended December 31, 2012.
    - Myriant- Myriant's high purity bio-succinic acid is a drop-in replacement for petroleum-based succinic acid. . Myriant’s bio-succinic acid will be available from two operating plants: Myriant’s first large-scale commercial production plant (30 million pounds/yr) in Lake Providence, LA USA. The second plant is located in Leuna, Germany (3 million pounds/yr).
    - Reverdia- Reverdia is a joint venture between Royal DSM, the global life sciences and materials sciences company, and Roquette Frères, the global starch and starch-derivatives company. Reverdia is dedicated to be the global leader in the market for sustainable succinic acid, focusing on market development by establishing partnerships with direct and indirect customers, building on customer needs and Reverdia strengths. Combining the knowledge

and experience of DSM and Roquette, Reverdia produces and sells Biosuccinium™, the Company's registered brand of bio-based succinic acid. Biosuccinium™, which is produced using a unique and proprietary low pH yeast technology, enables customers to produce bio-based, high-quality performance materials while at the same time substantially improving their environmental footprint. Roquette has a turnover of3 billion euros. DSM's 22,000 employees deliver annual net sales of around € 9 billion

***3.*** **Adipic Acid-** Adipic acid is a key component of nylon 6,6 and thermoplastic polyurethanes. Everyday products which contain adipic acid include clothing, footwear, furniture, carpets, automobile parts and nylon fabric.

- Verdezyne- Verdezyne is currently the only company that has demonstrated production and recovery of adipic acid at pilot scale through fermentation of low cost plant sourced oil feedstocks. Verdezyne has developed Generation-2 yeast for adipic acid production from palm oil fatty acid distillate (PFAD). The new generation of genetically modified yeast claims faster productivity, and a tolerance for the high pH environment resulting from high concentrations of adipic acid product (up to 10 weight percent) in the fermentation broth. Verdezyne estimated the ADA market size at 4.8bn lb, with a growth rate of 4.3%/year.
- Rennovia- California-based Rennovia, US was founded in 2009. Rennovia intends to start up its pilot scale bio-ADA production in December, a year after it initiated research and development (R&D) for the glucose-derived chemical. Rennovia's product uses glucose, which is converted into glucaric acid as an intermediate via oxidation with a catalyst. The glucaric acid is converted into adipic acid via the hydrogenation process. It produces water as a by-product. Rennovia estimated the global ADA market size at 4.8bn lb, with a growth rate of 3-5%/year

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