PathKinex™ Update: Spotlight on *Bacillus* DFMs for Biogas Production in Livestock Waste Management

Written by Amy Lange, Microbiologist III at Microbial Discovery Group

United Animal Health and Microbial Discovery Group have been uncovering new connections between gut microorganisms, digestibility, animal health and performance, and environmental factors since the beginning of our partnership. One prime example is our exploration of certain characteristics of *Bacillus* that allow it to improve nutrient digestibility in the GI tract and have a significant impact on the treatment of wastewater and liquid manure. This capability allows *Bacillus* DFMs to improve the performance of renewable natural gas systems that use anaerobic digesters or covered anaerobic lagoons to treat manure and recover extra energy from waste.

Renewable Natural Gas Systems Create a Demand for Microbial Treatment Products, Including *Bacillus* DFMs

Large cattle and swine producers are increasingly adopting biogas capture systems such as anaerobic digesters and covered anaerobic lagoons, which can effectively treat wastewater produced by large livestock operations while reducing noxious odor emmisions.[1] In these systems, methane-containing biogas produced by the anaerobic decomposition of manure solids is recaptured as renewable natural gas which can be used for fuel or electricity generation. Anaerobic digesters create a demand for biological products that can increase the hydrolysis of fiber, protein, and other nutrients present in the waste stream; promote microbial activity in the wastewater; and allow methanogenic archaea to convert volatile fatty acids (VFAs) to methane (Figure 1).[2]

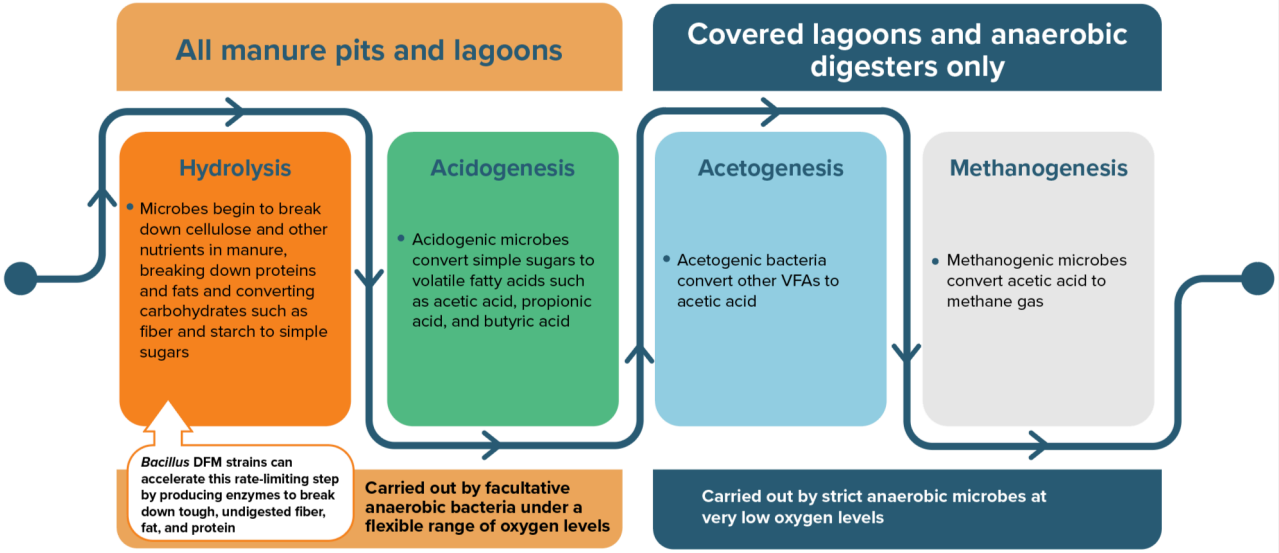

Figure 1: Major steps in the methanogenesis pathway. Click to enlarge

Can *Bacillus* increase methane production in anaerobic lagoons while reducing methane emissions in barns?

Yes! *Bacillus* exert most activity during hydrolysis, which is the first step of multiple metabolic pathways, including aerobic decomposition, anaerobic fermentation, and methanogenesis. The engineering of manure management systems (which includes factors such as storage time, aeration, agitation, and moisture level) promotes the growth of different microbial communities that create different end products, including carbon dioxide, organic acids, or methane.

Unlike most manure management systems, anaerobic lagoons operate at a low solids percentage and high water percentage, limit exposure to air to maintain anaerobic conditions, and promote the growth of strictly anaerobic microbes like acetogenic bacteria and methanogens. While all manure pits produce some methane, deep pits are not designed to optimize methane production due to their open construction and higher solids concentration. Therefore, treating deep-pit systems with *Bacillus* can accelerate solids removal, decrease the development of crust and foam that inhibit oxygen exchange, and promote fermentation by a mix of aerobic, microaerophilic, and facultative anaerobic bacteria.

Amnil® (DFM PAK® in the US) Improves Biogas Production from Liquid Swine Manure in an *in vitro* Methane Capture System

To simulate the impact of Amnil® (DFM PAK® in the US) treatment on a covered anaerobic lagoon system, we used an *in vitro* methane capture system to measure methane production in an in-lab model. Liquid swine manure from a shallow-pit barn housing market-weight grow-finish pigs with no DFM treatment was diluted to a typical solids concentration of an anaerobic lagoon and combined with a small amount of cellulose to serve as additional substrate for methanogenic microbes. DFM-treated replicates (n=6) with Amnil® applied just before the run and control replicates (n=6) receiving no treatment were incubated anaerobically until methane production leveled off.

Amnil®-treated liquid manure samples exhibited higher methane production than untreated manure samples, with a 46% difference between Amnil®-treated and untreated manure (Figure 2). Additional runs with manure from barns housing younger pigs showed differences in the biological activity of control vessels, but Amnil® treatment consistently improved methane yield under varied conditions, with a 20% to 40% difference between treated and untreated vessels.

Methane Production in an *in vitro* Batch System

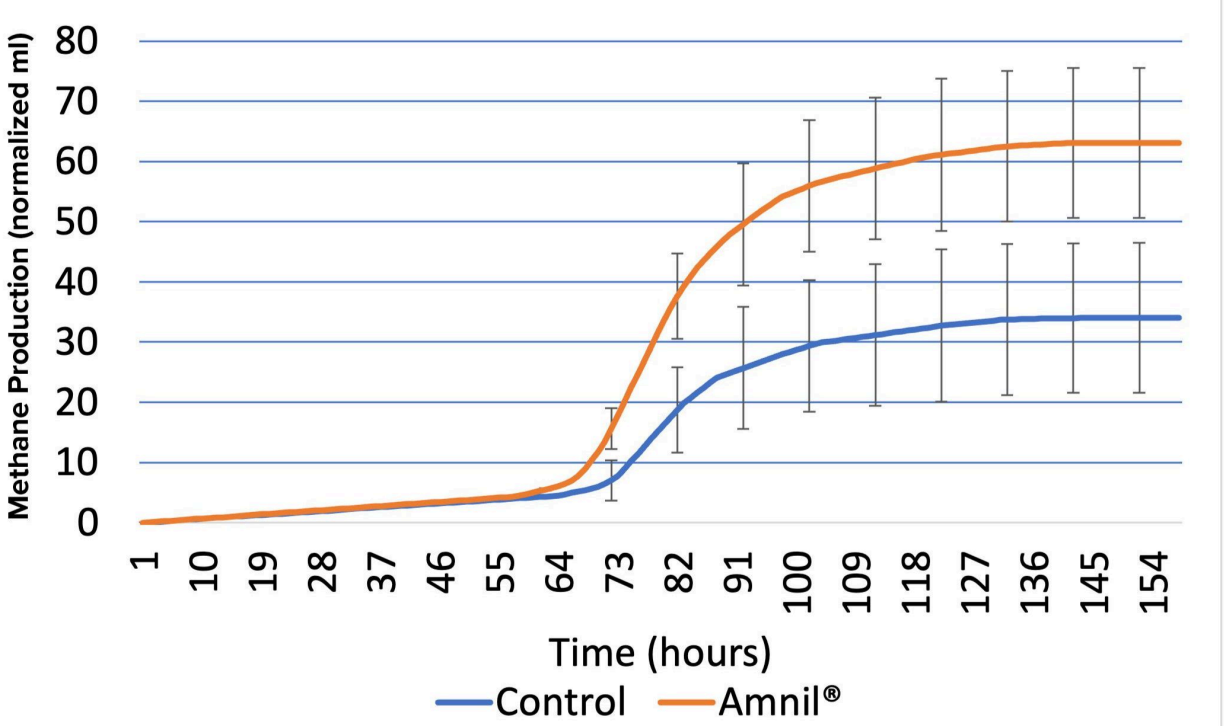

Figure 2: Gas production in an *in vitro* methane capture system in manure with and without Amnil® treatment.

Action

The *Bacillus* strains in Amnil® work through multiple modes of action, improving nutrient digestibility, influencing host health in the GI tract, and continuing to function in the manure and wastewater. Our in vitro biogas models provide evidence for the efficacy of Amnil® at improving methane production in an anaerobic lagoon model. Lab-scale models can be a powerful tool for early research and can provide strong support for the product's activity when combined with our ongoing field trials in real-world conditions.

Discussion Questions

Do you have clients using alternative waste streams, including covered lagoons or anaerobic digesters? If so, which ones? Do you believe there is there an unmet need for DFM products to solve biological problems in manure management systems?

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About the Author

Amy Lange is a Microbiologist III at Microbial Discovery Group. Her main research focus is in the use of direct-fed microbials to influence ruminant health and nutrition and the development of large-scale microbial surveillance platforms in animal agriculture.

References

1. Hamilton, D. W., Fathepure, B., Fulhage, C. D., Clarkson, W., & Lalman, J. (2006). Treatment lagoons for animal agriculture. In J. M. Rice, D. F. Caldwell, & F. J. Humenik (Eds.), *Animal agriculture and the environment: National center for manure & animal waste management white papers* (pp. 547–574). ASABE. https://doi.org/10.13031/2013.20266

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