

Exploring potential benefits of prebiotic, probiotic, and synbiotic use in cattle

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Project Title:

Prebiotic, probiotic, and synbiotic technologies for targeted applications in food safety and ruminant productivity

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Background:

Prebiotics are nutrient sources that favor the bloom of beneficial bacteria within the host animal. Probiotics are live cultures of bacteria that are fed to improve digestive system health. Synbiotics are the combination of probiotic and prebiotic strategies to achieve an improved health outcome. There is experimental evidence that probiotics and prebiotics may improve the health of monogastrics, but their potential benefits for ruminants are less well understood, due to the complexity of rumen microbiology. Short- and long-term outcomes of these products for ruminant productivity, metabolic efficiency, feed digestibility and food safety have not been assessed.

Objectives:

To develop a method to track prebiotic passage and utilization throughout the entire digestive tract and to determine effects of prebiotic treatments on artificial rumen community structure to identify potential prebiotic, probiotic and synbiotic formulations to improve feed conversion and animal productivity as well as monitor prebiotic, probiotic and synbiotic strategies aimed at mitigating foodborne pathogen persistence.

What they did:

The research team developed 'fluorescent glycan conjugates' (FGCs) as a tool to study interactions between prebiotics and probiotics. The FGC's allowed researchers to visualize which bacteria feed on a specific prebiotic. The researchers were then able to use the FGC's to identify rumen bacteria that may function as probiotics and new enzymes that may assist in the digestion of prebiotic feeds. The team developed two distinct classes of FGCs: one that is specific for studying carbohydrate active enzyme function (i.e. fluorescent oligosaccharides) and one that is specific for uptake by bacteria (i.e. fluorescent glycans). To study the interactions of FGCs with rumen bacteria the researchers isolated a large library of bacteria from artificial cattle rumen communities. These were fed with prebiotics (i.e. BIO-MOS® and distiller's grains, DDGS). Isolates were ranked based upon their ability to metabolise 'yeast mannan', a prebiotic carbohydrate that decorates the surface of common yeast cells. Researchers were able to use FGCs to study the uptake of prebiotics by these bacteria at the single-cell level in pure cultures and in communities extracted from the rumen of fistulated lambs.

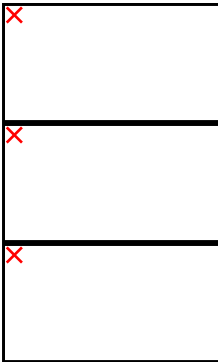
What they learned:

The research team discovered that there were two different growth profiles for rumen bacteria on yeast mannan: 'fast growers' (FGs) and 'medium growers' (MGs). Both FGs and MGs represent potential probiotics tailored for cattle rumens with different outcomes, so they wanted to clearly understand the genetic and functional differences between FGs and MGs. These studies identified two unique enzymes that have promise as feed additives for the improved digestion of YM containing feeds, such as distillers grains, which may also improve the digestibility of feed additives sourced from agricultural residues. The FGC tools were also able to identify differences in how rumen bacteria utilized prebiotics when sheep were fed different diets.

What it means:

Given the inconsistent performance of commercially available pre/probiotics for cattle, it was essential that the research team start with a better understanding of how bacteria interact with their nutrient sources. These were the initial steps in a painstaking, long-term initiative. Characterizing interactions of rumen bacteria with FGCs represents a first-in-class innovation for improving digestive health and feed efficiency in cattle. Additionally, the rumen models that the research team established will help create benchmarks for validating prebiotic-probiotic interactions, and evaluating their potential impacts on animal performance. Research like this greatly increases the odds of developing pre/probiotic solutions that provide predictable benefits for beef cattle health and performance.

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