Can prebiotics and probiotics help avoid respiratory disease and antimicrobial treatment in beef cattle?

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Project Title:

Enhancing the bovine respiratory microbiome through promoting commensal bacterial growth

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Background

Bovine respiratory disease (BRD) is among the most common needs for antibiotic use in feedlots. It is difficult to develop effective vaccines for respiratory diseases because they often have an environmental component and involve multiple bacterial or viral pathogens.

Researchers have recently gone back to the drawing board to look at the community of bacteria in the respiratory system of cattle (respiratory microbiome) to identify whether there are differences in the microbiomes of cattle that get sick and cattle that remain healthy.

Previous studies have found more lactic acid-producing bacteria (LAB) in animals that were resistant to BRD infection. Researchers have attempted to provide cattle with an intranasal dose of LAB to help prevent disease. They found this led to a reduction in the number of disease-causing organisms while the LAB were present but were not able keep LAB in the nasal cavity for a long duration.

Objective(s)

1. To characterize which prebiotics work best to encourage the growth of beneficial probiotics, and
2. To determine the effects of providing intranasal prebiotics and probiotics on the cattle respiratory microbiome.

What they did

In a first study, researchers evaluated the effects of the prebiotics lactulose, raffinose, and lactitol on cultures of 16 bacterial strains previously isolated from upper respiratory tract of feedlot cattle. The prebiotics were then tested for their effects on mixed bacterial cultures from the nasal swabs of calves. This was used to identify the best prebiotic for a study using beef cattle.

In a second study, the best prebiotic was tested alone and in combination with previously developed probiotic bacteria, for its effect on upper respiratory tract bacteria of calves. This was done by taking nasopharyngeal samples of calves and sequencing DNA specific to bacteria in the samples. The calves were assigned to one of five treatments (N=8 calves per treatment): 1) Syringe-Probiotic group received intranasal probiotic via a syringe that was attached to a 25-cm long catheter; 2) MAD-Probiotic group received an intranasal probiotic with a mucosal atomization device (a device that sprays the solution up the calf's nose); 3) MAD-Synbiotic group received an intranasal probiotic containing prebiotic lactulose (0.5%, suspended in saline) with a mucosal atomization device; 4) MAD-Prebiotic group received intranasal prebiotic lactulose (0.5%, suspended in saline) with a mucosal atomization device; 5) MAD-PBS (Control) group received only saline with a mucosal atomization device. Utilization of a syringe versus mucosal atomization device was tested to determine if mode of probiotic bacteria delivery had an impact on the respiratory microbiota.

What they learned

From the first study, growth of the pathogenic bacteria was not affected by any of the prebiotics, which was a primary consideration before their use in cattle. Lactulose and raffinose promoted growth of several commensal bacteria, including *Lactobacilllus*, *Lactococcus*, and *Streptococcus* strains, to a greater extent than lactitol, and were therefore selected for their effects on mixed bacterial cultures using bacteria from the nasopharynx of feedlot cattle as inoculant. It was shown that only lactulose was capable of modulating the structure and diversity of bacteria in the mixed cultures, primarily due to utilization by *Streptococcus*. Given the results of these *in vitro* experiments, lactulose was selected as a prebiotic to administer to cattle intranasally.

When administered to cattle intranasally, lactulose had no effect on the diversity or community structure of bacteria and had limited prolonged effect on specific bacteria. In addition, when administered in combination with probiotic bacteria, colonization of the probiotics was not enhanced. The abundances of pathogenic bacteria associated with BRD were low in all calves and not reduced by probiotics. However, the probiotic did affect the structure of respiratory bacteria and increased interactions between respiratory bacteria. There is evidence to show that bacterial community interactions are important to resisting pathogen growth, therefore this may benefit cattle respiratory health. The strongest affect was observed when probiotic bacteria were administered alone, using an atomization device.

What it means

Overall, this study showed that cattle respiratory bacteria can be altered by administration of probiotics and may therefore provide new opportunities to enhance respiratory resistance against BRD pathogens. Advancements in the development of probiotics may lead to their use as part of management strategies to reduce antimicrobial use, though it is unlikely they will serve as direct alternatives to antibiotics. While colonization and growth of probiotic bacteria in the respiratory tract are unlikely to be modified by prebiotics delivered in saline solution, the delivery method and time of application are important factors that need to be evaluated to have optimal efficacy of biologicals.

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