# Improving the barrier function of the gut to prevent disease

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## Project Title:

Improving the barrier function of the gut: an approach to minimize production limiting diseases

## Researchers:

**Greg Penner, Ph.D.** greg.penner@usask.ca

Greg Penner, Ph.D., University of Saskatchewan, Steve Hendrick, DVSc., John McKinnon, Ph.D. and John Campbell, DVSc. (University of Saskatchewan)

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- Effect of ruminal acidosis and short-term low feed intake on indicators of gastrointestinal barrier function in Holstein steers

***Background***

Stressful situations often have long lasting implications to animal health and welfare, especially when it comes to the health of the gastro-intestinal (GI) tract. Two common ways cattle undergo nutritional stress to their GI tract are: reductions in feed intake, (stressful events such as weaning, transport, or weather events) and ruminal acidosis (caused by consuming a high grain diet when the stomach is improperly adapted such as when transitioning to a finishing diet, after a storm, or overfeeding).

The cells lining the digestive tract have two seemingly contradictory functions. They need to absorb nutrients while also acting as a barrier to prevent disease causing organisms and compounds from entering the bloodstream.

Nutrient absorption has not been studied in great detail in ruminants, and barrier function even less so. The interplay between these two functions also raises the possibility that nutritional disruptions may also affect how well the gut can act as a barrier to pathogens.

Understanding nutrient absorption and barrier function better will help to identify opportunities to improve feed conversion efficiency, as well as a better understanding of how to avoid diseases that are believed to result from pathogen movement across the digestive system (including laminitis, acute interstitial pneumonia, liver abscesses, and general systemic inflammation).

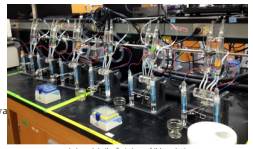
***Objectives***

To better understand the interplay between the absorptive and barrier functions of the ruminant digestive tract

***What They Did***

Experiment 1: Tissue was collected from 8 locations along the gastro-intestinal tracts of 6 calves immediately after death. These 8 regions where then cleaned and mounted in an Ussing chamber, which allowed researchers to keep the tissue alive outside of the animal and measure the permeability of the gut (ability of non-desired molecules to cross the tissue) to different sized particles and therefore barrier function of the tissue as it would be if it were still in the live animal. This information was needed to assess which regions of the gut are at most risk under healthy conditions.

Experiment 2: A total of 21 steers were randomly assigned to either control, ruminal acidosis, or feed restriction treatments (7 per treatment). At the start of the trial all steers were fed a diet of 25% barley silage, 25% grass hay, 28% rolled barley grain, 5% pelleted barley, 9% canola meal, and 8% of a pelleted vitamin and mineral supplement. On day 20 the steers in the rumen acidosis group were fed 25% of their regular diet and then returned to the previous ration for the next four days. The feed restriction group were fed 25% of the original ration for 5 days. Feed samples, and animal health measures were collected. After the trial period was over all steers were killed and tissue samples were collected and mounted in Ussing chambers as in experiment 1.



Lab work in the first stage of this project.
Photo credit: Tracy Sakeuth

Experiment 3: 32 wether lambs were used in this trial, (since lambs have a very similar digestive system to cattle they can be used as a model for the ruminant digestive system and researchers can use more animals for a lower cost). Lambs were split into 4 groups, 1) control (CON); 2) high grain recovery (HG); 3) storm recovery (STORM); and 4) storm plus feed additives during recovery (STORM+). All lambs were fed a free choice finishing diet. Once adapted to the diet all groups but CON were feed restricted for 3 days (fed only 50% of what they were receiving previously). Lambs then underwent a 5-day recovery period where they were returned to the free choice finishing diet. During the recovery period lambs in the HG group were provided just the finishing diet, lambs in the STORM group were provided a diet with a lower grain content (higher forage) than what they had been receiving previously, and STORM+ were given the STORM diet plus additional feed additives (butyrate, rumen protected betaine, and an antioxidant blend). Feed samples, and animal health measures were collected. After the trial period wa over all lambs were killed and tissue samples were collected from the four most promising locations along the gastro-intestinal tract (as found in experiment 1 and 2) and mounted in Ussing chambers as in experiment 1.

***What They Learned***

Experiment 1: In this study they discovered that sections of the intestine were more permeable than the rumen indicating that future work aimed at developing strategies to reduce gut permeability in the intestine may be effectiv at improving digestive health

Experiment 2: researchers were unable to detect a change in permeability of the gut lining due to acidosis. This may have been due to the short time between when acidosis was induced and when animals were killed but could also mean that animals compensate for acidosis by reducing gut permeability. These results further suggest that permeability for large molecules is greater in the rumen and omasum, and permeability for small molecules is greatest in the proximal regions of the small intestine (as found in study 1)

Experiment 3: lambs in the STORM and STORM+ groups had a numerically higher dry matter intake during the recovery phase as well as a higher (more normal) rumen pH compared to the HG group. When examining the tissues, they discovered that tissue from lambs in the HG group showed signs of inflammation. Lambs in the STORM+ group seemed to have a better ability to absorb nutrients across the gut (especially in the intestinal portion) than those in the other groups that were feed restricted. This study provided new information that feed additives have the potential to minimize the impact of nutritional challenges or accelerate recovery of the gut from those challenges.

***What it Means***

This research is a long way from being commercially applicable, however, two of the additives used are licensed (butyrate and antioxidants) and available. This research has identified opportunities to simultaneously improve feed efficiency, animal health and welfare, and industry competitiveness. This has given researchers a better understanding of how the ruminant digestive system works and is the first step in helping to build strategies to better manage when animals go off feed.

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**For More Information Contact:**
Beef Cattle Research Council
#180, 6815 - 8th St. NE
Calgary, AB T2E 7H7
Tel: (403) 275-8558 Fax: (403) 274-5686
info@beefresearch.ca

**For More Information Visit:**
www.beefresearch.ca