The Ruminant Nutrition Symposium titled “Acidosis: New insights into the persistent problem” was held at the Joint Annual Meeting of the American Dairy Science Association, American Society of Animal Science, Poultry Science Association, Asociación Mexicana de Producción Animal, Western Section-ASAS, and the Canadian Society of Animal Science in Denver, Colorado, July 11 to 15, 2010. The objective of the symposium was to provide the ruminant nutrition community with new insights and perspectives from recent research findings on acidosis. Under modern production systems, ruminants are fed high-grain diets to maximize their energy intake and productivity. However, feeding highly fermentable diets often causes excess fermentation and results in accumulation of fermentation acids in the rumen, leading to a decrease in feed intake, poor feed efficiency, liver abscesses, and lameness in feedlot cattle or lactating dairy cows. Although our understanding of nutritional factors (i.e., effects of type and processing method of grains and importance of physically effective fiber) affecting rumen pH have increased substantially over the past few decades, rumen acidosis has continued to be a common problem in the ruminant livestock industry. The symposium program was organized to review recent research findings in acidosis with more emphasis on physiological aspects, and provide novel insights into the persistent problem.

Key words: acidosis, ruminant

Joerg Aschenbach (Free University of Berlin, Berlin, Germany), as the first speaker of the symposium, discussed the role of fermentation acid absorption in regulation of rumen pH (Aschenbach et al., 2011). Lipophilic diffusion has been considered the primary mode of short-chain fatty acid absorption in the rumen, but Aschenbach et al. (2011) showed that bicarbonate-dependent absorption, exchange of dissociated short-chain fatty acid with bicarbonate across the apical membrane, was another primary absorption pathway of short-chain fatty acids. Ruminal epithelia can secrete bicarbonate at a capacity equal to that from saliva, thus removing protons from the rumen by neutralization. Proton removal via NH$_4^+$ absorption across the apical membrane is another possible mechanism to remove protons, and the interaction of protein metabolism and short-chain fatty acid absorption is an interesting area for further research. However, the rumen epithelium recycles protons via Na$^+$/H$^+$ exchangers, decreasing rumen pH, although its activities may be essential to maintain epithelial integrity and protect animals from acidosis. The effect of proton recycling on rumen pH regulation was also identified as an area that warrants research in future.

Better understanding of molecular-level adaptation of ruminal epithelia to highly fermentable diets provide the physiological basis to further elucidate specific roles of ruminal epithelia in regulation of rumen pH (Penner et al., 2011). As the second speaker of the symposium, Greg Penner (University of Saskatchewan, Saskatoon, Canada) showed that epithelial proliferation, changes in activity and transcription of transport protein and ketogenic enzymes, and enhanced barrier functions are physiological adaptations to decreased pH and greater concentrations of fermentation acids and toxins in the rumen. It is widely accepted that butyrate induces epithelial proliferation, but discrepancies between in vitro and in vivo findings in the literature indicate that positive effects of butyrate on epithelial proliferation are
likely mediated by systemic growth factors. Enhanced rumen fermentation affects activities or transcriptions of anion exchangers, \( \text{Na}^+ / \text{H}^+ \) exchangers, and key enzymes involved in ketogenesis; these intracellular adaptations seem to precede proliferation or morphological adaptation of epithelia. Epithelial barrier function, which is essential to protect animals from bacterial toxin, seems to increase with greater fermentation in the rumen, but its regulatory mechanisms are not well understood.

Tanya Gressley (University of Delaware, Newark), the third speaker for the symposium, showed that hindgut acidosis is often associated with ruminal acidosis and reviewed factors affecting hindgut acidosis and its consequences in animal health and productivity (Gressley et al., 2011). Hindgut fermentation contributes up to 10% of dietary energy intake in cattle, and hindgut has some capability to adapt to increased flow of OM and its fermentation. However, because of a lack of salivary buffer secretion, absence of protozoa, and less-protective epithelial layers, hindgut epithelia might be more susceptible to damage caused by excess fermentation compared with ruminal epithelia. Symptoms of hindgut acidosis are similar to those in subacute rumen acidosis, including reductions in nutrient digestibility, fluctuations in feed intake, and milk fat depression. Hindgut acidosis can be detected by observation of feces: watery or foamy feces, or presence of mucin in feces indicates excessive fermentation in the hindgut. With hindgut acidosis, bacterial toxins and amines may enter the systemic circulation, increasing the risk of health disorders such as laminitis.

The symposium concluded with a review by Pia Andersen (University of Royal Veterinary and Agricultural University, Denmark) on effects of rumen acidosis on inflammatory responses (Andersen, 2010). Highly fermentable diets increase ruminal concentration of gram-negative bacteria and their structural component lipopolysaccharide, a known endotoxin. Endotoxins that enter the systemic circulation are recognized by the innate immune system and elicit inflammatory responses. Although translocation of endotoxin across the rumen wall increases particularly with rumenitis or impaired epithelial barrier function, acute phase protein concentrations in blood often increase even with subacute rumen acidosis. A large variation exists in susceptibility of animals to endotoxin, and causes for this variation need to be investigated.

Acidosis is a persistent problem affecting the sustainability of ruminant livestock industry. The Ruminant Nutrition Symposium encouraged the ruminant nutrition community to consider novel management approaches to mitigate health problems associated with rumen acidosis. Animals are extremely variable in their tolerance of highly fermentable diets, but the physiological basis of this variation has not been well understood. The symposium highlighted nondietary physiological factors, such as capacity for fermentation acid absorption, that are heavily involved in regulation of rumen pH (Aschenbach et al., 2011). As such, epithelial molecular-level adaptation to highly fermentable diets, in addition to epithelial proliferation, should be considered as a possible management target to reduce severity of rumen acidosis (Penner et al., 2011). The symposium also brought awareness that negative effects of rumen acidosis are not limited to the microbial ecosystem in the rumen. Recent research findings indicate that rumen acidosis is often associated with hindgut acidosis, negatively affecting nutrient digestibility and animal health (Gressley et al., 2011) and that translocation of endotoxins cause systemic inflammatory responses (Andersen, 2010). The current symposium enhanced our understandings of regulatory mechanism of rumen pH and physiological consequences associated with rumen acidosis.

**LITERATURE CITED**


