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MEAT & LIVESTOCK AUSTRALIA

Reducing Emissions from Livestock Research Program

Microbial ecology of hydrogenotrophic rumen microorganisms in response to methane inhibitors

Management of hydrogen in the rumen is an important factor to be considered when developing strategies to control ruminant methane emissions.

Generally, the focus in methane mitigation tends to be on the amounts of methane produced. However, by considering the disposal of hydrogen that can impair digestion and fermentation if it accumulates, a 20–50% reduction of methane production can be achieved without reducing feed intake or liveweight. This could also increase energetic efficiency of digestion by 2–5% (and possibly more on high roughage diets).

An understanding of the microorganisms and main metabolic pathways in the rumen is helpful in devising strategies to manage hydrogen utilisation in the rumen for reduced methanogenesis.

This project supports a collaboration with the National Institute of Livestock and Grassland Science (NILGS) in Japan to foster exchange of scientific knowledge and technology between Australia and Japan in the field of ruminant gut microbiology and greenhouse gas abatement from livestock, with emphasis on methanogenesis and hydrogen utilisation.

Methane production and rumen hydrogen concentration are measured in open-circuit respiration chambers equipped with hydrogen sensors during trials feeding different levels of methane inhibitor.

The program

The Reducing Emissions from Livestock Research Program is a national collaborative program focused on developing practical on-farm options for significantly reducing emissions from livestock while simultaneously increasing productivity. The research will develop more accurate data on emissions from sheep and cattle and the levels of mitigation achieved using a range of strategies.

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Project objective

To determine the natural ability of the rumen to utlise hydrogen when methanogenesis is reduced and identify the microorganisms and underpinning genetics involved in the alternative hydrogen utilising pathways to methane generation.

Progress

NILGS has a unique capability in conducting animal measurements of methane and hydrogen emissions in open-circuit respiration chambers, and energy metabolism in large and small ruminants. This will enable us to conduct a properly designed trial with adequate replication of animal numbers. Furthermore, the Japanese facility has automated and continuous measurement of expired gases, which provides accurate estimates of methane and hydrogen produced in animals fed methane inhibitors.

The aim of the collaboration is to deliver new knowledge about the presence of acetogenic and hydrogenotrophic bacteria in the digestive tract of ruminants, and their contribution to hydrogen sequestration when methane is inhibited and hydrogen accumulates in the rumen.

This information will provide insights into the ecology of organisms involved in alternative pathways to methanogenesis for carbon and hydrogen sequestration. The potential to enhance the competitive role of these organisms with methanogens – and thus reduce methane emissions – will be explored based on this new knowledge. Ultimately, we expect to determine the degree of methane reduction and subsequent hydrogen accumulation that does not adversely affect rumen fermentation, and promote these conditions under industry practice.

A trial has commenced using four rumen-fistulated goats at NILGS in Japan. Methane and hydrogen production have been measured in these animals using open-circuit respiration chambers while feeding the methane inhibitor, bromochloromethane (BCM). Methane output was significantly reduced using the BCM-inhibition technique. However, there were no differences in the digestibility or maintenance intake of the rations offered with the additive BCM, eventhough hydrogen accumulated above normal levels suggesting that alternative pathways such as propionate production are controlling the negative impacts of this gas. Monitoring of key microbial populations showed that changes did not limit fibre digestion. In addition “deep sequencing” of the rumen microbiome revealed increases in populations that are consuming hydrogren in response to inhibition of methane formation.

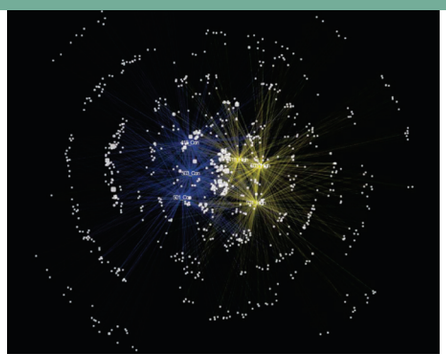

Image of OTU network map which shows microbial members positively or negatively affected by BCM in the diet.

National Institute of Livestock and Grassland Science (NILGS) in Japan.

Automated gas monitoring at NILGS, Japan.

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