Assessment of Rumen Microbiota in Beef Cattle with Different Feed Efficiency on Grazing Rangeland

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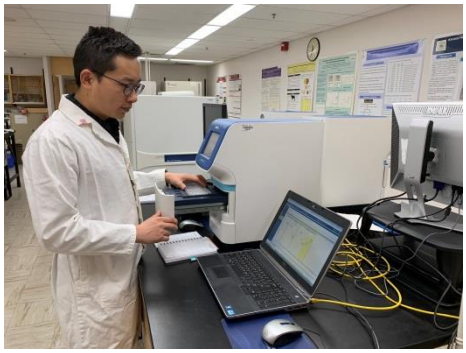
Sustainability is critical for the long-term success of the Canadian beef industry. This requires improvement in production efficiency as well as reduced environmental impact. In Canada, most cow-calf producers utilize pasture grazing during the summer to maintain favorable growth with lower costs. Recent studies from Dr. Guan's group have demonstrated a strong relationship between the rumen microbiota and both feed efficiency and methane emission of feedlot beef cattle. However, the role of the rumen microbiota when cattle are grazing on pasture has not been studied due to the challenges of collecting rumen samples and measuring performance traits (such as feed efficiency and methane emission). The objectives of this study were to characterize variation in rumen microbiota and fermentation profiles in grazing cattle and to assess whether they are associated with variation in feed efficiency measured in drylot.

Mattheis Ranch, July 2018. Photo by Lisa Raatz.

Because residual feed intake (RFI, one measure of feed efficiency) is a moderately heritable trait, this project assessed rumen microbiota of 60 heifers who were selected to be divergent in terms of feed efficiency. Briefly, the high RFI (inefficient) heifers were daughters of high RFI cows that were bred with high RFI bulls, while low RFI (efficient) heifers were from low RFI cows crossed with low RFI bulls. The RFI of these 60 heifers was tested under drylot conditions with a conventional barley silage diet at the Lacombe Research Centre and rumen fluid samples were taken at the end of the RFI test. These heifers were then transferred to the Mattheis Research Ranch, where they grazed on forage oats in mid-summer. Rumen fluid was collected from 8 high RFI and 8 low RFI heifers after grazing.

First, we compared the concentration of short chain fatty acids (volatile fatty acids (VFA)) in the rumen between the two management systems and different RFI groups. The VFA profiles showed no significant difference in total VFA or individual VFAs. However, grazing cattle had a lower acetate:propionate ratio in the rumen compared to drylot animals for both efficient and inefficient cattle. The rumen microbial

populations, including bacteria, archaea, protozoa, and fungi, were also compared using a molecular based method. Briefly, microbial populations were evaluated using quantitative polymerase chain reaction (qPCR) to measure the copy number of unique marker genes for each microbial group. Results showed that inefficient cattle had fewer rumen protozoa, more rumen bacteria and a trend for more rumen methanogens when grazing on pasture compared to when they were fed in drylot (Figure 1). However, this difference was not observed within the efficient cattle. These results suggest that rumen microbiota may be more stable (and adaptable) in efficient cattle between production environments, making them more sustainable overall.



MSc student Junhong Liu measures the microbial population of cattle rumen fluid using qPCR techniques.

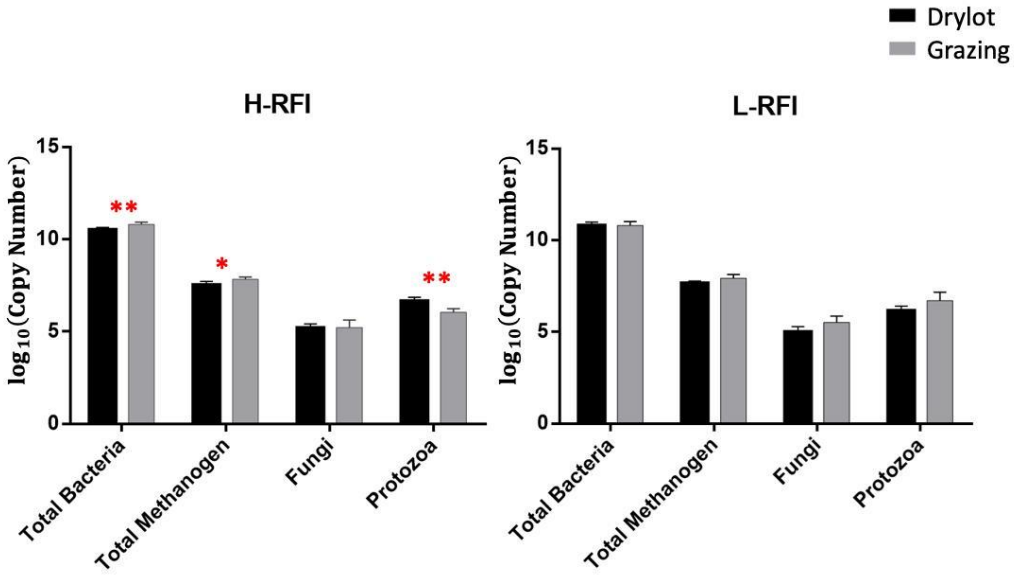


Figure 1. Determination of microbial populations using qPCR. Results showed that the rumen microbiota of efficient (L-RFI) and inefficient (H-RFI) heifers responded differently to the environment change.

**: $p < 0.05$
*: $0.05 < p < 0.1$

In conclusion, rumen microbiota profiles of cattle grazing on pasture were different at both the population and compositional level compared with those in the drylot. Such differences may lead to altered microbial functions and warrant further study. In addition, the rumen microbiota of efficient and inefficient cattle responded uniquely when the feeding system was changed from drylot to open pasture grazing. These findings add to our understanding of the rumen microbiota and its function in grazing beef cattle. This knowledge will help develop management strategies that optimize beef production efficiency and reduce the environmental impact of cattle raised within these production systems in western Canada.

Lui, J., Lansink, N., Bork, E., Carlyle, C., Plastow, G., Guan, L. 2018. Assessment of Rumen Microbiota in Beef Cattle with Different Feed Efficiency Grazing on an Oat Pasture. Journal of Animal Science 96(Supp):192 (PS I-39).