**10.6** MEASUREMENT OF METHANE EMISSIONS FROM CATTLE USING CHAMBERS AND MICROMETEOROLOGICAL TECHNIQUES

Sean M. McGinn*, Karen A. Beauchemin and Trevor W. Coates
Agriculture and Agri-Food Canada, Lethbridge, Alberta

## 1. INTRODUCTION

Methane emitted from the livestock sector accounts for 38% of all agricultural greenhouse gas (GHG) emissions in Canada (Environment Canada 2002). Understanding the relationship of diet to enteric methane production is essential to reduce uncertainty in GHG emission inventories and to identify viable GHG reduction strategies.

For the cattle industry, reducing methane means an improvement in feed efficiency. Mitigating methane loss from cattle has both long-term environmental and short-term economic benefits. Dietary changes can impact methane emissions by decreasing the fermentation of organic matter the rumen, shifting the site of digestion from the rumen to the intestines, diverting H away from methane production during fermentation, or by inhibiting methanogenesis by rumen bacteria (Johnson and Johnson 1995; Benchaar et al. 2001).

Most enteric methane measurements for cattle have been conducted using masks and hoods (Kelley et al. 1994; Boadi et al. 2002). Whole animal calorimetric chambers have also been adapted to measure methane emissions (Amon et al. 2001; Moss 2002). Masks, hoods and chambers allow comparison between treatments but interfere with activity of cattle. Measurements made under production situations would allow a more realistic evaluation of enteric methane. For example, barns have been equipped to estimate methane emissions (Kinsman et al. 1995; Jungbluth et al. 2001). Micrometeorlogical methods are also employed to determine methane emissions without restricting the activity of cattle (Harper et al. 1999).

The objective of our study was to quantify the impact of different diets on enteric methane emissions of cattle. In addition to whole cattle chambers, we also used micrometeorological techniques to assess methane under normal feedlot conditions.

* *Corresponding author address:* Sean M. McGinn, Agriculture and Agri-Food Canada, Environmental Health, 5403 – 1 Ave. South, Box 3000, Lethbridge, Alberta, Canada T1J 4B1; e-mail mcginn@agr.gc.ca

## 2. MATERIALS AND METHODS

*Chamber*: Two experiments were conducted using eight steers housed in four chambers. In Exp. 1, dietary treatments were: control or additives of monensin, sunflower oil or proteolytic enzyme. In Exp. 2 treatments were: control, or additives of Procreatin-7 yeast, Levucell SC yeast or fumaric acid. Each chamber was equipped with an open-path laser to measure methane concentration every 30 min for 3 d each period (21 d).

Two additional experiments were conduced to measure methane emissions related to type of feed. Following the same protocol as in Exp. 1 and 2, corn and barley were compared for both high forage (Exp. 3) and high grain (Exp. 4) diets.

*Micrometeorology*: Two isolated pens were constructed (each 15 by 15 m) and equipped with open-path methane lasers to monitor the concentration at four levels on the eastern perimeter. Wind speed at each level was also measured. The heights of the measurements were 0.5, 1.5, 3.0 and 5.5 m. These data were averaged every 30 min and used in an integrated horizontal flux approach to determine methane emission per head of cattle in each pen.

## 3. RESULTS AND DISCUSSION

*Chamber:* In Exp. 1 and 2, about 6.5% of the energy consumed was lost in the form of methane emissions for cattle fed the control diet. Methane emissions varied from 129 to 181 g/steer d. In Exp. 1 (Fig. 1), sunflower oil reduced methane emissions by 22% compared with the control, while monensin and enzyme had no effect. When $CH_4$ emissions were corrected for differences in energy intake, the loss of energy to methane was reduced by 21% using oil and by 9% using monensin. In Exp. 2 (Fig. 1), yeast and fumaric acid had no effect on $CH_4$ emissions, although emissions, as a percentage of energy intake, were 3% lower for steers fed Procreatin-7 yeast compared with the control.

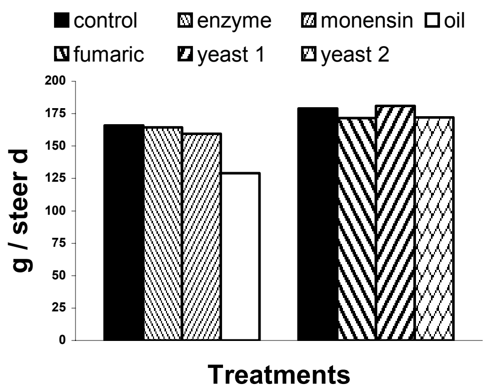


Fig.1 Methane emissions from steers fed additives as measured with chambers in Exp.1 and 2.

In Exp. 3 and 4 (Fig. 2), cattle fed a high forage diet produced higher methane emissions (209 to 402 g/steer d) than found for those fed a high grain diet (93 to 167 g/steer d). For a predominately forage diet, corn was associated with the highest emissions whereas for the predominately grain diet, barley produced the greatest emissions.

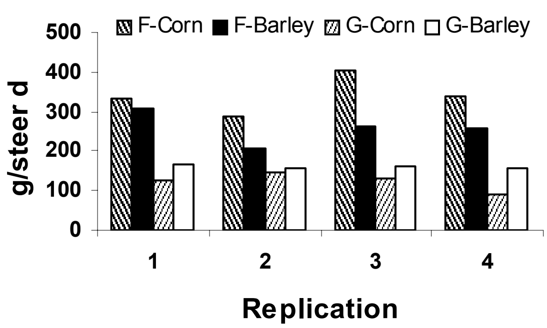


Fig. 2. Methane emissions from steers fed corn and barley (F-forage and G-grain) as measured with chambers in Exp. 3 and 4.

*Micrometeorology:* Methane emissions from open pens of beef cattle averaged (over 65 days for periods with westerly winds) 4.1 (± 2.8) g/(steer 30-min) for pen 1 and 5.7 (± 3.9) g/(steer 30-min) for pen 2. The average methane emitted from all pens, prorated for 24 hours, was 236 g/steer d.

Work is progressing on the measuring methane emitted from commercial livestock facilities using open-path laser technology. This approach relates measured plume characteristics to emissions using a backward dispersion model (WINDTRAX, Thunder Beach Scientific).

## 4. CONCLUSIONS

The study demonstrates that sunflower oil, ionophores, and some yeast products can be used to reduce the energy intake lost as methane from cattle. Furthermore, there was a difference in methane emissions between corn and barley fed at high forage or high grain levels. The chambers were sensitive enough to detect difference due to dietary treatments. Methane fluxes emitted from open pens of steers (236 g/steer d) that were fed a forage based diet, were comparable to those measured using the chamber technique.

## 5. REFERENCES

Amon, B., Th. Amon, J. Boxberger and Ch. Alt., 2001: Emissions of $NH_3$, $N_2O$ and $CH_4$ from dairy cows housed in a farmyard manure tying stall (housing, manure storage, manure spreading). *Nut. Cycl. Agroecosyst.* **60**, 103-113.

Benchaar, C., C. Pomar, and J. Chiquette, 2001: Evaluation of dietary strategies to reduce methane production in ruminants: A modeling approach. *Can. J. Anim. Sci.* **81**,563-574.

Boadi, D.A., K.M. Wittenberg and A.D. Kennedy, 2002: Validation of the sulphur hexafluoride ($SF_6$) tracer gas technique for measurement of methane and carbon dioxide production by cattle. *Can. J. Anim. Sci.* **82**, 125-131.

Environment Canada, 2002: Canada's Greenhouse Gas Inventory 1990-2000, Government of Canada EPS 5 /AP/ 8.

Harper, L.A., O.T. Denmead, J.R. Freney and F.M. Byers, 1999: Direct measurements of methane emissions from grazing and feedlot cattle. *J. Anim. Sci.* **77**, 1392-1401.

Johnson, K.A., and D.E. Johnson, 1995: Methane emissions from cattle. *J. Anim. Sci.* **73**,2483-2492.

Jungbluth, T., E. Hartung and G. Brose, 2001: Greenhouse gas emissions from animal houses and manure stores. *Nut. Cycl. Agroecosyst.* **60**,133-145.

Kinsman, R., F.D. Sauer, H.A. Jackson, and M.S. Wolynez, 1995: Methane and carbon dioxide emissions from dairy cows in full lactation monitored over a six-month period. *J. Dairy Sci.* **78**, 2760-2766.

Moss, A.R., 2002: Environmental control of methane production by ruminants. *In*: Greenhouse Gases and Animal Agriculture (eds. J. Takahashi and B.A. Young). Elsevier Science B.V., New York. Pp. 362.