International Congress Series 1293 (2006) 152–155

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Effects of various feed additives on the methane emissions from beef cattle

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Abstract. The objective of this study was to identify feed additives that reduce methane emitted from growing beef cattle fed high forage diets. We measured enteric methane for 72 h in three experiments using whole animal chambers. Exp. 1 and 2 used Holstein steers (311.6 ± 12.3 kg), whereas Exp. 3 used Angus heifers (260 ± 32 kg). The basal diet consisted of 75% whole crop barley silage (dry matter basis, DM). Treatments were: control (no additive), unsaturated fats (sunflower oil, 50 g/kg DM; canola oil, 46 g/kg DM), monensin (33 mg/kg DM), proteolytic enzyme (1 mL/kg DM), fumaric acid (12 and 29 g/kg DM), essential oil (161 mg/kg DM), and yeast (Levucell, 149 mg/kg DM; Procreatin, 536 mg/kg DM). Sunflower oil reduced methane emissions per unit of gross energy (GE) intake by 22%, with 25% of this reduction attributed to a decline in diet digestibility. Canola oil reduced methane emissions per unit of GE intake by 21%, but 70% of this reduction was due to a depression in diet digestibility. Monensin reduced methane emissions by about 9% without reducing diet digestibility. None of the other products tested reduced methane emissions in a statistically significant manner, although a numerical (3%) reduction in methane was observed for Procreatin yeast which requires further evaluation. This study demonstrates that diet modification can be used by the cattle industry to reduce its greenhouse gas emissions. Of the ingredients tested, sunflower oil and monensin offer the greatest reductions in methane without substantial reductions in diet digestibility.

Keywords: Beef cattle; Feed additive; Greenhouse gas; Methane

1. Introduction

Energy lost as enteric methane (CH_4) from cattle ranges from 2% to 12% of gross energy (GE) intake [1]. The Intergovernmental Panel on Climate Change, Tier 2 [2] estimates that cattle lose 6% of GE intake as CH_4, except for feedlot cattle for which 3.5%

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0531-5131/
doi:10.1016/j.ics.2006.01.042

of GE intake is lost as CH_4. Cattle producers are seeking to identify and promote good management practices that reduce production of greenhouse gasses from their operations. Reducing CH_4 can be economically beneficial as it coincides with greater feed efficiency by the animal.

The purpose of our study was to investigate the impact of several feed additives and ingredients that are currently registered for feeding to cattle on enteric CH_4 production.

2. Materials and methods

Three experiments were conducted to determine the effects of commercially available feed additives on CH_4 emissions from beef cattle fed high forage diets. Each experiment was conducted as a 4×4 Latin square and cattle were cared for according to the guidelines of the Canadian Council on Animal Care. Experimental periods were 21 days in length. Exp. 1 and 2 used Holstein steers (311.6 ± 12.3 kg), whereas Exp. 3 used Angus heifers (260 ± 32 kg). The basal diet, offered once daily, consisted of 75% whole crop barley silage, 19% steam-rolled barley, and 6% supplement (dry matter (DM) basis). Treatments are described in Tables 1 and 2 and detailed experimental protocols are given elsewhere [3,4].

After 17 days of receiving the treatment, the cattle were moved to four chambers (2 animals/chamber) for CH_4 measurement. Pairing of animals was consistent throughout each experiment and animals within a chamber received the same treatment. Measurements were recorded for 72 h. Airflow and concentration of CH_4 was measured for the intake and exhaust ducts of each chamber [3]. Methane emissions were expressed per unit of GE and digestible energy (DE) intakes (DE measured using an indigestible marker).

The data for each experiment were analyzed using the mixed model procedure of SAS (SAS Inst. Inc., Cary, NC). The chamber (data for two animals) was the experimental unit for CH_4 and the model included the fixed effects of treatment and the random effects of chamber nested within group and period nested within group. Day (1 to 3) was treated as

Table 1
Description of the various additives and ingredients used

Exp.	Additive	Amount (/kg DM)	Source
1	Control	No additive	
	Proteolytic enzyme	1 mL	Protex 6-L,Genencor International, Inc., CA
	Monensin	33 mg	Rumensin, Elanco Animal Health, Indianapolis, IN
	Sunflower oil	50 g	Unknown
2	Control	No additive	
	Procreatin-7 Yeast	536 mg	Prince Agri Products, Inc., Quincy, IL
	Levucell SC Yeast	149 mg	Lallemand, Inc., Rexdale, ON, Canada
	Fumaric acid—low	12 g	Bartek Ingredients Inc., Stoney Creek, ON, Canada
3	No additive	None	
	Fumaric acid[a]—high	29 g	Bartek Ingredients Inc., Stoney Creek, ON, Canada
	Essential oil	161 mg	Crina ruminant, Akzo Nobel Surface Chemistry S.A., Cedex, France
	Canola oil	46 g	Canbra Foods Ltd., Lethbridge, AB, Canada

[a] Sodium bicarbonate (12 g/kg DM) was added to neutralize the acidity of the high fumaric acid treatment.