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Corn Oil Supplementation on Performance and Methane Production in Finishing Steers

Tommy M. Winders

Brad M. Boyd
University of Nebraska-Lincoln, bboyd4@unl.edu

Henry F. Hilscher

Samodha C. Fernando
University of Nebraska-Lincoln, samodha@unl.edu

Rick R. Stowell
University of Nebraska-Lincoln, rstowell2@unl.edu

See next page for additional authors

Authors
Tommy M. Winders, Brad M. Boyd, Henry F. Hilscher, Samodha C. Fernando, Rick R. Stowell, and Galen E. Erickson

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Summary with Implications

A finishing trial was conducted to evaluate the effects of corn oil on animal performance, carcass characteristics, and methane production in finishing cattle. Corn oil was supplemented at 3% of the diet (dry matterbasis) and led to a decrease in intake, a numerical improvement in average daily gain, and improved feed efficiency compared to the control cattle. Dry matter intake while in the methane barn was not decreased between treatments, although it was numerically similar to what was observed outside of the methane barn. Corn oil did not affect any carcass parameters. Methane production (g/d) was reduced with the inclusion of corn oil compared to the control. Methane (g/lb of gain) was also reduced with the inclusion of corn oil compared to the control. A numerical reduction of methane (g/lb of intake) was observed when corn oil was included in the diet. Corn oil appears to be a viable option for both improving performance as well as decreasing methane production in beef cattle finishing diets.

Introduction

Methane production from ruminant animals has been a focus in research studies due to the environmental concerns associated with rising levels of greenhouse gases. Ruminants, especially beef cattle, have received attention due to the amount of methane they contribute to the global methane budget. Ruminants contribute 17% of the global methane production, but when fed grain, like in the US, cattle produce less per unit of energy intake. The environmental concerns are a main reason that mitigation strategies are being pursued in cattle production, but the energetic loss to the animal associated with methane production is another concern. A strategy for methane mitigation is through lipid supplementation. There are three ways that dietary lipids reduce methane: 1) biohydrogenation of fatty acids, 2) increased propionate production from lipolysis converting triglycerides to glycerol, which is then converted to propionate by anaerovibrio lipolytica bacteria, and 3) reduction in available fermentable substrate in the rumen as fatty acids are not fermentable. Fats are an energetic feed and can improve performance as well as mitigate methane, but should not be included in excess of 6–7% of dietary dry matter (DM) as rumen fermentation can be reduced at higher inclusion levels. The objective of this study was to evaluate the effect of corn oil supplemented at 3% of diet DM on performance and methane production.

Table 1. Treatments fed to control and corn oil cattle on finishing diets (DM basis)

Ingredient, % of diet DM	Control	Corn Oil
Dry-rolled corn	33	31.5
High-moisture corn	33	31.5
Wet distillers grains plus solubles	15	15
Corn silage	15	15
Corn oil	-	3
Supplement[1]		
Fine ground corn	1.368	1.368
Limestone	1.640	1.640
Tallow	0.100	0.100
Urea	0.500	0.500
Salt	0.300	0.300
Beef Trace Mineral[2]	0.050	0.050
Vitamin A-D-E[3]	0.015	0.015
Rumensin[4]	0.017	0.017
Tylan[5]	0.011	0.011

[1]Supplement fed at 4% diet DM
[2]Premix contained 10% Mg, 6% Zn, 2.5% Mn, 0.5% Cu, 0.3% I, and 0.05% Co
[3]Premix contained 1,500 IU of vitamin A, 3,000 IU of vitamin D, and 3.7 IU of vitamin E per g
[4]Formulated to supply Rumensin-90 (Elanco Animal Health, Greenfield, IN) at 30 g/ton
[5]Formulated to supply Tylan-40 (Elanco Animal Health) at 8.8 g/ton

Procedure

A 127-day finishing study was conducted using 80 steers (initial BW = 814 lb; SD = 55). Cattle were limit-fed a common diet of 50% alfalfa and 50% Sweet Bran (Cargill Corn Milling, Blair, NE) at 2% of body weight (BW) for 5 d (to equalize gut fill) and weighed on two consecutive days in order to obtain an accurate average initial BW. Steers were blocked by BW within previous treatment (ad-libitum or limit-fed forage diets; *2018 Nebraska Beef Cattle Report*, pp. 55–56), stratified within BW block, and assigned randomly to pens. Pens were assigned randomly to one of two treatments (Control and Corn Oil; Table 1), with 10 steers/pen and 4 pens/treatment.

The corn oil was sourced from an ethanol plant and displaced 3% of a dry-rolled corn (DRC):high-moisture corn (HMC) blend with corn oil (DM basis). Cattle were adapted to the finishing diet over a 24 d step-up period. Adaptation diet included

15% wet distillers grains plus solubles, 4% supplement, and displaced 81% corn silage down to 15% with DRC:HMC blend. Corn oil was introduced on day 18. The supplement was formulated to provide 30 g/ton of Rumensin (Elanco Animal Health) and 8.8 g/ton of Tylan (Elanco Animal Health). On d 1, cattle were implanted with 100 mg trenbolone acetate and 14 mg estradiol benzoate (Synovex Choice, Zoetis Animal Health). The steers were harvested on d 128 at Greater Omaha (Omaha, NE). Hot carcass weight and liver abscesses were recorded during harvest, and a dressing percentage of 63% was used to calculate final BW. Following a 48-hr chill, fat thickness, LM area, and USDA marbling scores were recorded and yield grade was calculated.

Steers were rotated through two pen-scale methane chambers with two side-by-side enclosed dry-lot pens sharing a middle wall. Gravity inlets on the south wall of the building allowed air to enter the chambers. Air is drawn through the inlets using two fans on the north wall, creating a negative pressure system. Air is pulled through each chamber and exits through the fans, with a sampling line positioned above the fans. Fans were calibrated twice, once prior and once after the trials (FANS System, Iowa State University). Airflow through the chambers with two fans running was 2800 cubic feet/minute. Air in each chamber was pulled into a sampling line with a pump. Solenoids controlled by a data logger cycled airflow from outdoors (ambient air), chamber 1, and chamber 2 to the gas analyzers, allowing air from each chamber to be analyzed for 6 minutes of each 20-minute cycle, with 2-minute or 6-minute ambient air flushes occurring between chambers.

Gas concentration data were averaged across each 6-minute measurement period, excluding readings for the first 30 seconds after solenoid switching to ensure that gases from the previous source were evacuated from the system. Daily gas production was calculated as an average of all of the 6-minute concentrations, minus the average ambient concentrations, multiplied by the [constant] daily airflow through each chamber. Each week, measurements were taken with cattle in the methane barn for five consecutive days, then with the cattle removed and manure remaining for 1 d, followed by manure being removed and clean chambers for 1 d. With eight total pens of cattle and two chambers in the methane barn each pen of cattle was in the barn for one 5 d period every 4 weeks. Each treatment was represented during every weekly sampling period in the methane barn, as each block replication had emission collections at the same time. Each pen of cattle had three 5 d collection periods throughout this trial, and pens were alternated between chamber 1 and chamber 2 each rotation through the methane barn.

Data were analyzed using the MIXED procedure in SAS as a randomized complete block design with all blocks (n=4) having one replication. Pen was the experimental unit and BW block was treated as a fixed effect. Gas production data were gathered over three periods, so the data were analyzed using repeated measures. Treatment, period, and block were included in the model as fixed effects. Treatment-by-period interactions were tested for methane production across time, but were not significant, therefore, main effects will be shown.

Table 2. Effects of corn oil supplementation (3% of diet DM) in finishing diets on cattle performance and carcass characteristics

	Control	Corn Oil	SEM	*P*-value
Performance				
Initial BW, lb	815	813	2	0.54
Final BW, lb	1302	1314	8	0.38
DMI, lb / d[1]	25.7	24.6	0.2	0.03
ADG, lb /d	3.84	3.96	0.04	0.15
F:G	6.69	6.22	-	0.02
Carcass Characteristics				
HCW, lb	821	828	5	0.39
LM area, in^2	12.7	13.1	0.18	0.26
Fat thickness, in	0.57	0.55	0.03	0.63
Marbling score[2]	497	484	9	0.43
Calculated YG[3]	2.98	2.85	0.09	0.35

[1]DMI over the 127 d trial

[2]Marbling score: 400 = Small^{00}, 450 = Small^{50}, 500 = Modest^{00}, etc.

[3]YG = 2.50 + (0.9843 * rib fat thickness, cm) + (0.2 * 2.5% KPH), + (0.0084 * HCW)–(0.0496 * LM area, cm^2) (USDA, 2016)

Results

Performance

Performance data are shown in Table 2. Initial BW and final BW were not different ($P \geq 0.39$), while dry matter intake (DMI) was reduced ($P = 0.02$) for cattle fed 3% corn oil compared to the control. Corn oil did not show a significant effect ($P = 0.14$) on average daily gain (ADG), although a numerical improvement of 3% was observed for the corn oil treatment. Feed conversion (F:G) was improved ($P = 0.02$) by 7% for the corn oil cattle over the control cattle, which is what is expected as ADG was not different but DMI was lower for the corn oil cattle. All carcass characteristics were similar between treatments in this trial ($P \geq 0.27$).

Methane

Methane data are shown in Table 3. Methane production (g/d) was reduced ($P = 0.03$) by 13% with the inclusion of corn oil relative to the control diet. Methane production (g/d) was greater as time on feed (period) progressed, regardless of treatment, shown by the period effect ($P < 0.01$). Methane (g/lb DMI while in the chamber) was numerically reduced by 13% when corn oil was included compared to the control. This study showed a 15% reduction ($P < 0.01$) in methane as g/lb ADG when corn oil was included compared to the control. Methane production from manure without cattle in the pens was small (0.9 g/steer daily). Methane from manure may be underestimated using these methods because of continuous methane release from the manure over the 5 d period, resulting in less volatiles being released on d 6 (during the measurement period) than when first excreted from the animal. Cattle were not present while manure emissions were

Table 3. Effects of corn oil supplementation (3% of diet DM) on methane production from cattle fed finishing diets

	Control	Corn Oil	SEM	*P*-value	
				TRT	Period
DMI, lb[2]	23.7	23.1	0.5	0.72	0.80
Methane					
g / d	132	115	3	0.03	< 0.01
g / lb DMI[1]	5.13	4.68	0.09	0.04	-
g / lb DMI[2]	5.82	5.05	0.43	0.29	0.50
g / ADG[3]	34.3	29.1	0.4	< 0.01	-

[1]DMI over the 127 d trial

[2]DMI in the methane barn across all 3 periods of collection

[3]ADG, lb over the 127 d trial

being measured. During the day of manure measurements alone, the manure is not being mixed by cattle activity, which could also reduce emissions. All data reported in tables 2 and 3 have ambient air concentrations of methane removed from the concentrations measured in each chamber to get more accurate production of gases. All of the gas production results shown in tables 2 and 3 are pen totals divided by ten to express values on a per-steer basis.

Conclusion

Supplementing 3% corn oil (DM basis) to finishing cattle reduced DMI, but resulted in numerically greater ADG as well as improved feed conversions. Supplementing corn oil reduced the amount of methane produced per day and per unit of gain (g/d, g/lb ADG) and numerically reduced methane per unit of intake (g/lb DMI) compared to the control. Overall, supplementing corn oil to finishing cattle seems to be a viable way to decrease methane production while improving cattle performance if supplemented at 3% of diet DM with 15% distillers grains. Price and logistics of feeding corn oil would need to be considered by producers prior to adding back dietary corn oil.

Tommy M. Winders, graduate student

Brad M. Boyd, research technician

Henry F. Hilscher, feedlot manager

Samodha C. Fernando, assistant professor

Rick R. Stowell, associate professor

Galen E. Erickson, professor, University of Nebraska–Lincoln, Department of Animal Science, Lincoln, Neb.