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Evaluation of the Impact of an Alternative Corn Residue Harvest Method on Performance and Methane Emissions from Growing Cattle

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Summary

A growing study was conducted to evaluate the impact of alternative corn residue harvesting methods and inclusion of Rumensin® on performance and methane to carbon dioxide ratio (CH_4:CO_2) of steers. Use of the alternative harvesting method resulted in greater ADG and improved F:G ratio than traditionally harvested cornstalks. Rumensin increased ADG and improved DMI; however, it did not have an impact on F:G ratio. Altering the composition of baled corn residue did affect CH_4:CO_2, while inclusion of Rumensin, whether included in the diet on a constant or rotational basis, had no impact.

Introduction

There is a significant potential for the utilization of corn residues as feed. The increase in corn production in recent years has resulted in an increased availability of residue for cattle producers. With increased residue, there have been advancements in harvesting methods allowing producers to alter the composition of plant parts available in the bale. New harvest methods now allow the producer to decrease the amount of the stalk in the bale compared to conventional baling. Studies have shown the digestibility of corn plant parts differ, with the husk being the most digestible and the stalk being the least digestible (*2012 Nebraska Beef Cattle Report,* pp. 11-12). The benefit of being able to alter the composition of plant parts in the bale is to improve the quality of harvested corn residue. Our objective was to determine if one of the new harvest methods results in an improvement in the performance of growing steers and to determine the effect that these differing feeds have on methane to carbon dioxide ratio.

Procedure

An 89-day growing study was conducted utilizing 60 crossbred steers (initial BW= 683 ± 61 lb) that were individually fed with the Calan gate system. Steers were limit-fed a diet of 50% alfalfa and 50% Sweet Bran® at 2% of BW for five days prior to the start of the trial to reduce variation in gut fill. Three consecutive weights were collected, utilizing the average as initial BW. Steers were blocked into 10 blocks according to initial BW, assigned randomly to one of six treatments within block; with 10 steers per treatment. Steers were implanted with Ralgro® on day 1 of the trial. Six forage-based treatment diets consisted of one of four forages: sorghum silage, corn stalks, husklage, and ensiled husklage (Table 1). Two additional ensiled husklage diets were included, one with no Rumensin for the duration of the study, and one which included Rumensin (200mg/head/day) on a rotational basis in three-week intervals. All the diets included SoyPass® and Sweet Bran. SoyPass was included in the diets to meet or exceed metabolizable protein requirements. The Sweet Bran was included to improve the palatability of the dry residues and to supply rumen degradable protein.

The husklage was produced with the use of a John Deere 569 round baler that was modified with the Hillco single pass round bale system (SPRB). This modification to the baler allows the baler to connect to the combine, where it collects the residue as it passes through the combine. This allows the producer to harvest both corn and residue in one pass through the field. The husklage had an average DM of 60%. The residue collected was 27% leaf, 17% husk, 42% cob, and 14% upper stem. Ensiled husklage was produced by adding water to the husklage to a DM content of 35% and bagging in an agricultural bag for a minimum of 30 days prior to initiation of the experiment.

Feed refusals were collected and weighed weekly, then dried in 140°F

Table 1. Composition of growing diets (DM basis).

Ingredient, % of DM	Sorghum Silage	Cornstalks	Husklage	Ensiled Husklage +	Ensiled Husklage -
Sorghum silage	62.0	—	—	—	—
Cornstalks	—	62.0	—	—	—
Husklage	—	—	62.0	—	—
Ensiled husklage	—	—	—	62.0	62.0
Sweet Bran	30.0	30.0	30.0	30.0	30.0
SoyPass	3.0	3.0	3.0	3.0	3.0
Fine-ground corn	3.31	3.44	3.44	3.44	3.45
Limestone	1.18	1.05	1.05	1.05	1.05
Tallow	0.13	0.13	0.13	0.13	0.13
Salt	0.3	0.3	0.3	0.3	0.3
Trace mineral	0.05	0.05	0.05	0.05	0.05
Vitamin A-D-E	0.02	0.02	0.02	0.02	0.02
Rumensin[1]	0.01	0.01	0.01	0.01	—

[1]Diets containing Rumensin were formulated to provide 200 mg/steer daily.

Table 2. Effects of forage with or without the inclusion of Rumensin on growing cattle performance and CH_4:CO_2.

Item	Sorghum Silage	Cornstalks	Husklage	Ensiled Husklage	Ensiled Husklage	Ensiled Husklage	SE	P-value
Rumensin[1]	+	+	+	+	-	+/-		
Initial BW, lb	682	680	682	691	682	680	5	0.53
Ending BW, lb	973[a]	837[d]	878[c]	916[b]	879[c]	874[c]	11	< 0.01
ADG, lb	3.27[a]	1.76[d]	2.20[c]	2.52[b]	2.21[c]	2.17[c]	0.11	< 0.01
DMI, lb	21.06[a]	13.87[d]	14.01[cd]	16.97[b]	14.98[cd]	15.54[bc]	0.67	< 0.01
F:G, lb/lb[2]	6.41[a]	7.84[c]	6.37[a]	6.73[ab]	6.73[ab]	7.15[b]	—	< 0.01
CH_4:CO_2[3]	0.092[a]	0.078[c]	0.084[b]	0.088[ab]	0.090[a]	0.088[ab]	0.002	< 0.01

[1]Rumensin + = diet contained Rumensin at 200mg/hea/day; Rumensin - = diet did not contain Rumensin; Rumensin +/- = Rumensin was rotated in and out of the diet every three weeks.
[2]CH_4:CO_2 = methane to carbon dioxide ratio; average of six time points during feeding period.
[3] Analyzed as gain to feed.
[a-d]Means within a row without a common superscript are different, ($P < 0.05$).

forced air oven for 48 hours to calculate an accurate DMI for individual steers. At the conclusion of the study, steers were again limit-fed for five days, the same diet as prior to the start of the trial. Weights were collected for three consecutive days and averaged to determine an accurate ending BW.

An *in vitro* procedure was performed twice in order to obtain an *in vitro* organic matter digestibility (IVOMD) on the husklage and ensiled husklage. Samples were dried in a 140°F oven for 48 hours, then ground through a 1-mm screen. An assay for *in vitro* OM (IVOMD) digestibility was then performed on the samples. Test tubes contained 0.5 grams of sample and 50mL of an inoculum. The inoculum for the procedure was a combination of rumen fluid from two donor steers that were fed a 70:30 forage: concentrate diet (DM-basis). Rumen fluid was filtered through four layers of cheesecloth to eliminate excess feed particles. The filtered rumen fluid was then put into separatory funnels and placed into a water bath in order to further separate small feed particles. McDougall's buffer was mixed into the rumen fluid at a 1:1 ratio, along with the inclusion of 1 gram of urea/L of buffer.

Once the test tubes were filled, they were placed in a water bath at 102°F for 48 hours to allow fermentation. To end the fermentation, each test tube received 6 mL of 20% HCL and 2mL of 5% pepsin solution. Tubes were then returned to the water bath for an additional 24 hours. At the end of the 24 hours the tubes were removed from the water bath and the residue was filtered through a non-ash filter. Filters were ashed at 600°C for a minimum of six hours.

To facilitate the collection of respired air by the cattle to be analyzed for methane and carbon dioxide, the individual Calan gate bunks were partially enclosed and outfitted with a small air pump that was used to gradually fill a gas collection bag. Gas collection was conducted at the time of feeding and gas sample bags were filled with air at a constant rate over approximately 10 minutes, once per week. Gas samples were collected only while steers were in their bunks. The collected gas consisted of a mixture of respired gasses and ambient air and was analyzed within 24 hours for concentration of methane and carbon dioxide in ppm using a gas chromatograph. Methane data are expressed as a ratio of methane to carbon dioxide (CH_4:CO_2) where CO_2 can be used as an internal marker since its production is relatively constant across cattle of similar size, type, and production level. Gas samples were collected from each steer approximately once per week throughout the feeding period.

Data were analyzed in the Mixed Procedures of SAS (SAS Institute, Inc., Cary, N.C.), with individual steer serving as the experimental unit. The model included treatment and weight block. The CH_4:CO_2 was analyzed as a repeated measure with six weekly measurements per steer.

Results

Effect of Forage Type

To evaluate the effects of forage type, comparisons were made only within diets which contained Rumensin for the entire feeding period. Steers fed sorghum silage had the greatest DMI and ADG compared to forage types ($P < 0.01$; Table 2). These steers consequently had the heaviest ending BW ($P < 0.01$), as they were consuming higher quality forage and at greater amounts. Steers consuming husklage had greater ADG, DMI, and an improved F:G ratio ($P < 0.01$) compared to the steers that were fed cornstalks. The cornstalks resulted in the lowest DMI, ADG, and greatest F:G ratio ($P < 0.01$). The John Deere SPRB appears to have been successful in improving the quality of residue that was baled, probably because the stalk was not collected in the bale. However, steers consuming husklage and ensiled husklage refused 5-8% of their daily feed offering vs. 2% for the cornstalks. Visual observation indicated they refused primarily the cob. Ensiling the husklage increased DMI and ADG ($P < 0.05$) but did not change F:G ratio ($P = 0.13$) compared to husklage that was not ensiled. The fact that feed conversion was not improved was supported by the *in vitro* digestibility analysis. The IVOMD of the husklage averaged 41.57% with the ensiled husklage averaging 36.74%. The CH_4:CO_2 results closely resemble the performance data. Steers fed

(Continued on next page)

stalks had the lowest DMI of the least digestible diet; therefore, had the lowest $CH_4:CO_2$ ($P < 0.01$; Table 2). Conversely, steers fed sorghum silage had greater $CH_4:CO_2$, reflective of their higher intakes of a more digestible diet, since methane production is largely driven by amount of fiber fermentation. Methane to carbon dioxide ratios was similar for cattle fed husklage or ensiled husklage ($P = 0.25$) and intermediate between the higher quality sorghum silage and the lower quality, unaltered cornstalks.

Effect of Rumensin Inclusion

Three ensiled husklage diets were utilized to evaluate the effect of inclusion of Rumensin for the entire 89 days (Rum +) compared with no Rumensin at any point during the study (Rum -), or an on/off rotation of Rumensin inclusion at three-week intervals (Rum +/-). Cattle receiving Rum+ had the greatest ADG ($P < 0.01$), while there was no difference between Rum - and Rum +/- ($P = 0.77$). Cattle fed Rum - had the lowest DMI, while those on Rum + had the greatest, and DMI of those steers on Rum +/- was intermediate ($P < 0.01$). No effect of Rumensin inclusion on F:G was observed ($P \geq 0.12$). Similarly, Rumensin had no impact on $CH_4:CO_2$ ($P > 0.36$). This lack of methane production response is not surprising considering the basal diets were identical and the effects of Rumensin on methane have been shown to be short lived in previous work. Our hypothesis that by rotating Rumensin inclusion, we could overcome any possible adaptation by the rumen microbes was not supported in this study.

These data suggest that by changing the harvest method of the corn residue, the quality could be improved compared to conventional cornstalks. This study also reinforces the conclusions from previous work (*2014 Nebraska Beef Cattle Report,* pp. 29-31), which demonstrated that in growing diets, forage quality is a main determinant of methane production.

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