Effects of Protein Supplementation in Corn Silage Growing Diets Harvested at 37 or 43% DM on Cattle Growth

F. Henry Hilscher, Robert G. Bondurant, Jana L. Harding, Terry J. Klopfenstein, and Galen E. Erickson

Summary

A growing study evaluated the effects of harvesting drier corn silage and response to rumen undegradable protein (RUP) supplementation. Corn silage was harvested at 37 or 43% DM from the same fields and protein supplement (high in RUP) was provided at 0.0, 2.5, 5.0, 7.5 or 10.0% of diet DM. Ending BW and ADG were decreased, while F:G was increased, when steers were fed 43% DM silage compared to 37% DM silage (88% silage inclusion). Increasing supplemental RUP in the diet increased ending BW, DMI, and ADG linearly, and decreased F:G linearly. Drier silage had less energy for growing steers while supplemental RUP improved gain and efficiency in silage growing diets.

Introduction

Feeding greater inclusions of corn silage during times of increased corn prices can be an economical alternative compared to corn, although ADG and F:G are not as favorable. Feeding corn silage allows cattle feeders to take advantage of the entire corn plant at a time of maximum quality and tonnage as well as secure substantial quantities of roughage/grain inventory (*2013 Nebraska Beef Cattle Report*, pp. 74–75). Plot work suggests that as corn harvest is delayed to black layer formation, corn and whole plant yield is maximized with little effect on nutritive quality as measured in the lab (*2013 Nebraska Beef Cattle Report*, pp. 42–43; *2016 Nebraska Beef Cattle Report*, pp. 79–80).

Corn silage typically contains 6.5 to 8.5% CP, most of which is in the form of RDP and is utilized for microbial protein synthesis. Our hypothesis was that very little protein from corn silage escapes the rumen (i.e., RUP) and previous estimates of RUP of silages are likely incorrect. Inadequate supplemental RUP could result in inadequately meeting metabolizable protein requirements (NRC, 2000). Thus, source and amount of supplemental protein are important factors affecting growth because supplemental protein provides a significant amount of the total dietary protein (2014 Professional Animal Scientist, pp. 327–332). Therefore, the objectives of this experiment were to determine the effects of delaying corn silage harvest on growing steer performance while determining RUP response when growing cattle are fed corn silage-based diets.

Procedure

Corn silage harvest data were previously presented (*2016 Beef Cattle Report* pp. 146–48). Corn silage was harvested at the Agricultural Research and Development Center (ARDC) near Mead, Neb. Harvest DM was targeted to mimic traditional corn silage harvest at 37% DM or a delayed harvest at 43% DM. Corn silage harvest was initiated when the field was at approximately ¾ milkline for the 37% DM corn silage (9/4/2014), and delayed two wks coinciding with black layer formation for the 43% DM corn silage (9/16/14). Corn silage was harvested in 4 replications within field and green chop samples were taken for DM determination on a Koster tester prior to bagging. Additionally, high moisture corn and dry corn yield strips were harvested within the same field on 9/18/14 and 11/4/14, respectively. Both 37% DM and 43% DM silages were stored in sealed AgBags and after 28 d, silage was sampled for fermentation analysis and DM samples were collected weekly during feedout (Table 1).

A 78-d growing study was conducted using crossbred steers (n = 60; initial BW = 597 lb; SD = 70 lb) that were individually fed using the Calan gate system. Trial initiation occurred after 4 months of corn silage harvest. Five days before trial initiation, cattle were limit-fed a common diet of 50% alfalfa hay and 50% Sweet Bran (Cargill, Blair, Neb) at 2% of BW to reduce variation in gut fill and then weighed on

Table 1. Nutrient and fermentation analysis of 37 and 43 % DM silage

Item	37 DM		43 DM	
	Mean	C.V.[a]	Mean	C.V.[a]
DM[b]	37.3	(3.2)	42.7	(3.9)
CP	7.51	(3.6)	7.50	(1.2)
NDF, %	31.55	(17.5)	28.88	(5.7)
ADF, %	21.38	(15.8)	18.63	(17.9)
Starch, %	35.4	(16.7)	40.8	(5.0)
Sugar, %	2.6	(19.6)	2.5	(8.7)
pH	3.88	(1.3)	3.85	(1.5)
Lactic acid, %	3.11	(26.9)	4.14	(28.1)
Acetic acid, %	3.98	(21.5)	2.81	(27.1)
Propionic acid, %	0.51	(26.8)	0.28	(54.3)
Butyric acid, %	< 0.01	(0.0)	< 0.01	(0.0)
Total acids, %	7.61	(10.5)	7.22	(3.3)

[a]C.V. = coefficient of variation and is calculated by dividing the standard deviation by the mean and is expressed as a percentage.
[b]DM was calculated using weekly samples and oven dried for 48 h at 600 C.
Note: All other samples are based on monthly composites, and analyzed at Dairyland Labs (St. Cloud, MN) and Ward Labs (Kearney, NE).

3 consecutive days, with the average used as initial BW. The common growing diet consisted of either 37% DM or 43% DM corn silage at 88% of diet DM, and treatments consisted of top dressing a blend of 0/100, 25/75, 50/50, 75/25, or 100/0 combination of a RDP and RUP supplement (Table 2). This combination allowed for 0, 2.5, 5.0, 7.5, or 10 % in the form of SoyPass (50% CP; 75% RUP as % of CP) and Empyreal (Cargill, Blair, Neb; 75% CP; 65% RUP as % of CP) in the growing diet. The supplement included Rumensin and was formulated to provided 200 mg/steer daily. Steers were stratified by day-1 and day 0 BW, and assigned randomly to 1 of 10 treatments (Table 2), arranged in a 2 × 5 factorial arrangement with 5 to 8 steers per level of RUP supplementation (n = 8 for 0% RUP; n = 5 for 2.5% and 5% RUP; n = 6 for 7.5% and 10.0% RUP treatments). With a limited number of bunks, a greater number of animals were used at 0% RUP inclusion to establish the intercept for response to supplemental RUP. In addition, a greater number of steers were in the7.5% and 10% supplemental RUP source treatments to establish the maximum gain response as it was hypothesized the metabolizable protein needs would be met. Steers were implanted with Ralgro on d 0. Steers were fed ad libitum once daily at 8 am. Feed refusals were collected weekly, weighed, and then dried in a 60°C forced air oven for 48 hours to calculate an accurate DMI for individual steers. At the conclusion of the study, steers were limit-fed the same diet as prior to the start of the trial at 2% of BW for 5 days. Weights were collected for 3 consecutive days and averaged to determine an accurate ending BW.

Data were analyzed using the mixed procedure of SAS as a randomized block design in a 2 × 5 factorial arrangement testing for linear and quadratic interactions between silage DM and RUP supplementation with steer serving as the experimental unit and weight block as a fixed effect. If no interactions were detected, the main effects of silage DM and supplemental RUP were evaluated. To evaluate RUP supplementation, linear and quadratic contrasts were developed to determine the effect of increasing RUP inclusion. Significance was declared at $P \leq 0.05$.

Table 2. Diet composition (% of diet DM) fed to individually-fed growing steers for 78 d

Ingredient	Treatment[a]									
	37% DM					43% corn silage				
	0.0%	2.5%	5.0%	7.5%	10.0%	0.0%	2.5%	5.0%	7.5%	10.0%
37% DM corn silage	88.0	88.0	88.0	88.0	88.0	—	—	—	—	—
43% DM corn silage	—	—	—	—	—	88.0	88.0	88.0	88.0	88.0
RDP supplement[b]	12.0	9.0	6.0	3.0	0.0	12.0	9.0	6.0	3.0	0.0
RUP supplement[c]	0.0	3.0	6.0	9.0	12.0	0.0	3.0	6.0	9.0	12.0

[a]Treatments: Diets contained 88% of either 37 or 43% DM corn silage and formulated to contain 0, 2.5, 5.0, 7.5 or 10.0% RUP.
[b]RDP supplement: was formulated for a target inclusion level of 12% and contained 9.35% soybean hulls, 1.2% urea, 0.45% dicalcium phosphorus, 0.40% salt, 0.3% tallow, 0.21% limestone, 0.05% trace minerals, 0.015% Vitamin A-D-E as a % of total diet DM. Formulated to provide 200 mg/steer daily of Rumensin (Elanco, Greenfield, IN :DM basis)
[c]RUP supplement: was formulated for a target inclusion level of 12% and contained 6.0% SoyPass, 4.0% Empyreal (Cargill branded corn gluten meal product, Blair, Neb), 0.42% soybean hulls, 0.3% urea, 0.2% dicalcium phosphorus, 0.30% Salt, 0.3% tallow, 0.40% limestone, 0.05% trace minerals, 0.015% Vitamin A-D-E as a % of total diet DM. Formulated to provide 200 mg/steer daily of Rumensin (% of diet DM)

Table 3. Effects of delayed silage harvest on growing steer performance

Item	Treatments[a]		SEM	*P*-value
	37% DM	43% DM		
Initial BW, lb	597	597	3.8	0.92
Ending BW, lb	846	826	6.7	0.04
DMI, lb/d	18.0	17.9	0.3	0.93
ADG, lb	3.19	2.93	0.07	0.01
Feed:Gain[b]	5.63	6.11	—	< 0.01

[a]Treatments: steers were fed 88% of either 37 or 43% DM corn silage.
[b]Analyzed as gain:feed, the reciprocal of F:G.

Table 4. The effects of increased inclusion of RUP in silage based growing diets on performance of cross bred steers

Variable	Treatments[a]					SEM	Lin.	Quad.
	0.0%	2.5%	5.0%	7.5%	10.0%			
Initial BW, lb	595	597	597	596	600	5.2	0.98	0.60
Ending BW, lb	791	824	855	842	868	9.1	< 0.01	0.88
DMI, lb/d	16.9	18.3	18.9	17.4	18.4	0.5	0.05	0.84
ADG, lb	2.51	2.91	3.31	3.15	3.43	0.09	< 0.01	0.82
F:G[b]	6.74	6.26	5.71	5.52	5.35	—	< 0.01	0.57

[a]Treatments: steers were fed 88% corn silage and a combination of RDP and RUP supplements to achieve either 0, 2.5, 5.0, 7.5 or 10 % RUP in the final diet.
[b]Analyzed as gain:feed, the reciprocal of F:G.

Results

There were no linear ($P \geq 0.33$) or quadratic ($P \geq 0.36$) interactions between corn silage DM and RUP supplementation for growing performance, therefore main effects will be discussed. As DM of corn silage increased from 37 to 43% there was a significant decrease ($P = 0.04$) in ending BW (Table 3). There was no difference ($P = 0.93$) in DMI between 37 or 43% DM corn silage, and ADG was reduced ($P = 0.01$) as DM of silage increased, which led to a significant increase ($P < 0.01$) in F:G.

As supplemental RUP sources in the growing diet increased from 0 to 10%, ending BW increased linearly ($P < 0.01$), with steers receiving 10% RUP sources having the heaviest ending BW and steers receiving 0% RUP having the lowest ending BW (Table 4). There was a linear increase ($P = 0.05$) in DMI as RUP inclusion was increased in the growing diet. Daily gain was improved as RUP inclusion increased in the growing diet, with ADG increasing ($P < 0.01$) linearly from 0 to 10% RUP inclusion. With both an increase in DMI and ADG, F:G decreased ($P < 0.01$) linearly as RUP inclusion increased. This indicates that increasing RUP in silage growing diets allowed for increased gains while increasing efficiency of gain.

Feeding silage in growing diets at 88% of diet DM indicates that 37% DM silage would result in greater ADG and lower F:G compared to 43% corn silage. Increasing the amount of RUP in silage growing diets resulted in linear increases in ending BW, DMI, ADG, and F:G. These results indicate that the addition of RUP into silage diets will improve performance by supplying more metabolizable protein. While the main effect of RUP inclusion was linear, the response is diminishing with increasing RUP. Supplementing 10% RUP may be insufficient to meet the metabolizable protein requirements and even greater inclusions may improve ADG and F:G further.

F. Henry Hilscher, graduate student

Robert G. Bondurant, research technician

Jana L. Harding, research technician

Terry J. Klopfenstein, professor, Animal Science University of Nebraska, Lincoln Neb.

Galen E. Erickson, professor, Animal Science