2017

Effect of Increasing Supplemental Rumen Undegradable Protein (RUP) on Performance of Calves Fed a Silage Growing Diet

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Summary with Implications

A growing study evaluated the effects of increasing supplemental rumen undegradable protein (RUP) on performance of calves fed an 85% corn silage diet. Five levels of supplementation were evaluated with 12 individually fed steers per level of supplement. Supplement levels consisted of 0, 3.25, 6.5, 9.75 and 13% supplemental RUP (% of diet DM) fed as a blend of 60% Soypass and 40% Empyreal. Increasing supplemental RUP in the diet increased ending body weight and average daily gain linearly, and decreased F:G linearly while DMI remained constant among treatments. As cattle grew from 600 to 730 lb, F:G was improved 30% by supplying RUP. The same amount of RUP improved F:G by 11% as cattle grew beyond 730 lb. By meeting MP requirements, supplementing RUP linearly improved both ADG and F:G of growing calves, especially early in the growing period.

Introduction

Although ADG may be diminished, feeding increased amounts of corn silage can be economically beneficial. Feeding corn silage allows cattle feeders to harvest the entire corn plant at the time of greatest forage quality and also provides a large quantity of affordable forage. Silage averages 6.5 to 8.5% crude protein, with most of it being rumen degradable protein (RDP) which is utilized for microbial protein synthesis. Corn silage is very low in rumen undegradable protein (RUP), which bypasses rumen degradation. Current estimates using a technique appropriate for silage suggests corn silage protein is 22% RUP (% of CP). Without adequate amounts of supplemental RUP, dietary protein will be limiting and will not meet metabolizable protein requirements, therefore negatively impacting cattle performance. Because supplemental protein provides a large amount of the total dietary protein, source and amount of supplemental protein is important. A similar study (2016 Nebraska Beef Report, pp. 49-51) looked at 0 to 10% supplemental RUP in 88% corn silage growing diets. They observed a linear increase in ADG and ending BW, suggesting that MP requirements were not met with the greatest level of supplement (10% supplemental RUP from Soypass and Empyreal®). Therefore, the objective of this study was to evaluate the effects of increasing supplemental RUP (up to 13% of diet DM) on growing performance of calves fed a silage based-diet.

Procedure

An 83-d growing study was conducted utilizing 60 crossbred steers (initial BW = 639; ± 40 lb). All steers were individually fed using the Calan gate system. Five days prior to trial initiation, steers were limit fed at 2% of BW to reduce gut fill variation. Steers were weighed on 3 consecutive days and the average was used as initial BW. The diet consisted of 85% corn silage with the remaining 15% fed as supplement (DM basis). The supplement included protein sources, urea, minerals, vitamins A-D-E, and a finely-ground corn carrier that was replaced with the RUP sources (Table 1). The RUP supplement consisted of 52% SoyPass (50% CP; 75% RUP as % of CP) and 34.7% Empyreal (Cargill; 75% CP; 65% RUP as % of CP). SoyPass is a enzymatically browned soy bean meal and Empyreal is a more processed corn gluten meal. Five levels of supplement were evaluated with 12 steers per level. Supplement levels consisted of 0, 3.25, 6.5, 9.75 and 13% Soypass + Empyreal (RUP sources as a % of diet DM). Steers were stratified by d-2 and-1 BW and assigned randomly to 1 of 5 treatments. All steers were implanted with Ralgro on d 0 and fed ad-libitum once daily at 8 a.m. Feed refusals were collected weekly, weighed, and then dried in a 60° C forced air oven for 48

Table 1. Diets fed to individually fed growing steers

	Treatment[1]				
Ingredient	0.0%	3.25%	6.5%	9.75%	13%
Diet composition, % of diet DM					
Corn Silage	85.0	85.0	85.0	85.0	85.0
RDP supplement[2]	15	11.25	7.5	3.75	0
RUP supplement[3]	0	3.75	7.5	11.25	15.0
Supplemented RUP[4]	0.4	1.7	3.0	4.2	5.5
Protein sources, % of diet DM					
Soypass	0	2.0	3.9	5.9	7.8
Empyreal	0	1.3	2.6	3.9	5.2
Urea	1.5	1.2	0.9	0.6	0.3

[1] Supplement levels consisted of 0, 3.25, 6.5, 9.75 and 13% Soypass + Empyreal (RUP sources as a % of diet DM).
[2] RDP supplement consisted of 79.2% corn, 2.9% limestone, 2.5% tallow, 9.7% urea, 2.0% salt, 3.2% dicalcium phosphate, trace minerals, vitamin A-D-E, and Rumension-90.
[3] RUP supplement consisted of 52% Soypass, 34.7% Empyreal, 1.9% corn, 3.2% limestone, 2.5% tallow, 1.7% urea, 2.0% salt, 1.5% dicalcium phosphate, trace minerals, vitamin A-D-E, and Rumension-90.
[4] % of RUP provided in the Supplement

hours to calculate an accurate DMI for individual steers. Interim weights were taken on d 36 and 37 and shrunk 4% to account for gut fill. At the conclusion of the study, steers were once again limit fed a diet of 50% alfalfa hay and 50% Sweet Bran (Cargill) at 2% of BW to account for gut fill. Weights were collected on 3 consecutive days and averaged to calculate an ending BW.

Data were analyzed using the mixed procedure of SAS as a randomized block design. To evaluate RUP supplementation, linear and quadratic contrasts were developed to determine the effect of RUP inclusion. Significance was declared at $P \leq 0.05$.

Results

No differences in DMI ($P = 0.84$) were observed among treatments for period 1 (d 1-37). However, ADG ($P < 0.01$) and F:G ($P < 0.01$) both improved linearly as RUP inclusion increased during period 1 (Table 2). Using the NRC model, MP balance (supply minus requirement of MP) for period 1 increased from-200 to +65 g/d as RUP inclusion increased from 0 to 13%. At 9.75% RUP inclusion, MP requirements were met (MP balance of +2 g/d). There were no differences in DMI, ADG or F:G for period 2 ($P \geq 0.11$; d 38-83). As RUP supplementation increased, F:G improved 30% in period 1. The increased improvement in feed efficiency in period 1 may be due to increased amino acid requirements of younger, lighter calves.

For the overall growing period (d 1-83), as supplemental RUP inclusion increased from 0 to 13%, a linear increase was observed in ending BW ($P < 0.01$). With no difference in DMI ($P = 0.54$) among the 5 treatments, averaging 17.1 lb/d, and a linear increase in ADG ($P < 0.01$), F:G linearly improved ($P < 0.01$) by 11% as RUP inclusion increased from 0 to 13%. The MP balance increased from-186 to +98 g/d as RUP inclusion increased from 0 to 13%. Providing 9.75% supplemental RUP in the diets was adequate to meet the MP requirements based on the 1996 NRC model (MP balance of +26 g/d). Even though MP requirements were met with both the 9.75 and 13% treatments, ADG continued to linearly increase up to 13% inclusion of RUP sources. This may be due to not meeting a lysine requirement with the 9.75% treatment. In period 1, the 13% RUP treatment had a lysine balance of +1.4 g/d. Diets were sufficient in lysine at only the greatest inclusion (13%) of supplemental RUP. Another explanation for additional improvement in ADG and F:G as supplemental RUP increased from 9.75 to 13% of diet DM is that excess MP provided from supplemental RUP can also be used as energy once MP requirements are met.

Conclusion

Further research with supplemental RUP needs to be done to determine if excess metabolizable protein would continue to increase growth due to protein (meeting lysine requirements) or used as energy. Increasing the amount of RUP in silage growing diets linearly improved ending BW, ADG, and F:G by meeting MP requirements of growing calves.

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Table 2. Effects of increasing RUP in silage based growing diets on steer performance

	Treatments[1]						*P*-value	
Variable	0%	3.25%	6.5%	9.75%	13%	SEM	Lin.	Quad.
Initial BW, lb	605	606	604	608	604	11.8	0.99	0.93
Ending BW, lb	800	825	821	850	834	16.6	0.01	0.68
d 1-37								
Interim BW, lb	692	707	713	730	729	14.7	0.03	0.69
DMI, lb/d	15.5	15.8	16.0	16.3	15.6	0.56	0.68	0.33
ADG, lb	2.35	2.73	2.95	3.30	3.38	0.21	< 0.01	0.52
F:G	6.59	5.79	5.43	4.94	4.62	—	< 0.01	0.76
d 38-83								
DMI, lb/d	16.9	18.8	18.3	18.5	18.3	0.70	0.22	0.16
ADG, lb	2.30	2.51	2.30	2.55	2.23	0.14	0.11	0.87
F:G	7.35	7.49	7.96	7.25	8.19	—	0.60	0.32
d 1-83								
DMI, lb/d	16.3	17.5	17.3	17.5	17.1	0.59	0.34	0.19
ADG, lb	2.32	2.61	2.58	2.88	2.74	0.12	< 0.01	0.55
F:G	7.02	6.70	6.69	6.09	6.25	—	< 0.01	0.61

[1] All cattle were fed 85% corn silage with a combination of RDP and RUP supplements to achieve either 0, 3.25, 6.5, 9.75, or 13% supplemental RUP (% of diet DM). The RUP source was a blend of Soypass + Empyreal in the final diet.