Effects of Increasing Supplementation of Rumen Undegradable Protein on Plasma Essential Amino Acid Concentrations in Beef Cows Consuming Low Quality Forage

A.S. Leaflet R2950

Taylor Geppert, Graduate Student,
Iowa State University Department of Animal Science;
Allison Meyer, Assistant Professor,
University of Missouri Division of Animal Sciences;
Patrick Gunn, Assistant Professor,
Iowa State University Department of Animal Science

Summary and Implications

The effects of pairing a low quality forage with increasing metabolizable protein (MP) supplementation from a moderately abundant rumen undegradable protein (RUP) source (corn gluten meal; 62% RUP) on essential plasma amino acid (AA) concentrations were evaluated in a 60-day trial. Non-pregnant, non-lactating cows (n=24) were offered ad libitum access to cornstalks and fed 1 of 3 isocaloric diets (0.48 NE_m/lb) and supplemented primarily with corn gluten meal to provide 100% MP requirements (CON), 125% MP requirements (MP125), or 150% MP requirements (MP150). It was observed that increasing concentrations of MP in the diet from a moderately abundant RUP source increased the percent of essential AA, ketogenic AA, branched-chain AA and urea cycle AA in plasma. Also, as a percent of total AA, glycogenic AA were decreased with increased MP supplementation. Therefore, increasing supplementation of MP can the shift essential AA profiles of beef cows when fed with low quality forage.

Introduction

Crude protein (CP) supplementation is a common practice with beef cattle producers today, and as the corn coproduct industry continues to expand, producers have a wide variety of economical feedstuff options to supplement cattle. However, when corn coproducts are fed, dietary CP is often in excess. In order to isolate the potential impacts of excess CP from these coproducts, a low fat, high RUP corn coproduct, such as corn gluten meal can be fed. Because diets with increased concentrations of RUP are degraded to a lesser degree in the rumen, it is likely that the plasma AA profile may more closely mimic the AA profile of the diet when compared with animals fed a diet comprised of increased levels of rumen degradable protein. Thus, it is conceivable feeding diets with elevated RUP concentrations may shift blood AA profiles, which could alter biological processes.

The objective of this experiment was to determine if increased supplementation of MP from a moderately abundant RUP source would affect beef cow essential plasma AA concentrations when consuming a base diet of low quality forage (corn stalks). As part of a larger study, we hypothesized that increasing MP supplementation in the form of corn gluten meal would have a positive impact on beef cow reproductive parameters around the time of ovulation, potentially through greater AA circulating concentrations. While adequate nutrition is essential for successful beef cow reproduction more research is needed to understand how excess dietary CP, and specifically RUP, impact circulating AA concentrations and biological processes around reproduction.

Materials and Methods

To study the effects of increasing MP supplementation on essential AA concentrations, non-pregnant, non-lactating mature beef cows (n=24; BW= 1174 ± 19.18 lb; BCS= 4.82 ± 0.07; Age= 6.21 ± 0.36 yr) were allocated by start BW, BCS and age, and assigned to 1 of 3 isocaloric diets. Diets consisted of ad libitum access to cornstalks paired with supplementation primarily of corn gluten meal, a moderately abundant RUP source, formulated to provide 100% MP requirement (CON), 125% of MP requirements (MP125) or 150% of MP requirements (MP150). Dietary supplements were individually delivered once daily for 60 days. Blood samples were taken prior to treatment initiation and on day 49 of the trial to determine a baseline and response to MP supplementation on plasma AA, respectively. Data were analyzed in SAS using orthogonal polynomial contrasts to determine linear and quadratic treatment effects. Diet supplementation formulation is located in Table 1.

Results and Discussion

On the first day of the trial, prior to diet delivery, there was no difference ($P > 0.15$; Table 2) in total AA, total essential AA or individual essential AA concentrations across treatment groups. On day 49, as a percent of total AA, ketogenic AA, branched-chain AA, urea cycle AA, leucine and phenylalanine linearly increased ($P < 0.01$; Table 2) with increasing MP supplementation. In addition, percent of essential AA and arginine tended to linearly increase ($P < 0.06$; Table 2) with increasing MP levels in the diet. As a percent of total AA, glycogenic AA, lysine and tryptophan linearly decreased ($P < 0.04$; Table 2), and threonine tended to linearly decrease ($P < 0.06$; Table 2) as MP supplementation increased. In conclusion, increasing concentrations of MP from a moderately abundant RUP source can have significant impacts on plasma AA concentrations in beef cows consuming low-quality forage. However, further research is needed to determine the physiological impacts of this shift in plasma AA concentrations.

Table 1. Supplement provided to cows consuming ad-libitum corn stalks.

	Treatment		
Item	CON	MP125	MP150
Dry matter intake, lb/d			
Corn silage	0.54	0.54	0.54
Corn gluten meal (62%)	0.13	0.69	1.48
Cracked corn	1.38	0.70	---
Mineral	0.25	0.25	0.25
Calculated nutrient intake			
CP, lb/d	0.26	0.55	0.96
NEm, Mcal/d	1.96	1.80	1.83

Table 2. Plasma amino acid concentrations from beef cows supplemented increasing levels of MP from a moderately abundant RUP source.

	Treatment				*P*-value	
Amino Acids, μmol/L	CON	MP125	MP150	SEM	Linear	Quadratic
Total AA						
Initial	1364	1556	1485	72	0.25	0.15
Final	1542	1497	1520	55	0.77	0.62
Total Essential AA						
Initial	564	614	590	40	0.66	0.45
Final	609	619	648	33	0.42	0.82
% Histidine of Total AA						
Initial	2.43	2.37	2.34	0.09	0.50	0.91
Final	3.41	3.31	3.17	0.12	0.16	0.89
% Arginine of Total AA						
Initial	3.05	2.78	2.64	0.19	0.14	0.76
Final	2.96	3.16	3.62	0.24	0.06	0.65
% Threonine of Total AA						
Initial	3.49	3.12	3.17	0.19	0.24	0.37
Final	2.64	2.38	2.18	0.17	0.06	0.87
% Lysine of Total AA						
Initial	5.89	5.36	5.57	0.43	0.60	0.50
Final	5.15	3.82	3.56	0.38	< 0.01	0.26
% Methionine of Total AA						
Initial	1.05	1.01	1.02	0.03	0.49	0.49
Final	1.15	1.15	1.15	0.04	0.96	0.90
% Valine of Total AA						
Initial	10.26	9.88	9.87	0.33	0.42	0.66
Final	8.97	9.62	9.68	0.30	0.11	0.43
% Isoleucine of Total AA						
Initial	4.67	4.37	4.50	0.17	0.48	0.29
Final	4.83	4.56	4.45	0.19	0.17	0.73
% Leucine of Total AA						
Initial	5.92	5.73	5.84	0.21	0.78	0.56
Final	5.73	8.74	10.02	0.34	< 0.01	0.05
% Phenylalanine of Total AA						
Initial	3.08	2.87	3.14	0.15	0.77	0.21
Final	3.01	3.17	3.56	0.11	0.01	0.41
%Tryptophan of Total AA						
Initial	1.62	1.59	1.53	0.09	0.49	0.84
Final	1.51	1.28	1.23	0.08	0.02	0.37
% Essential AA of Total AA						
Initial	41.46	39.09	39.63	1.23	0.30	0.34
Final	39.36	41.19	42.62	1.15	0.06	0.89
% Glycogenic AA of Total AA						
Initial	63.16	65.11	64.50	1.12	0.41	0.36
Final	66.10	63.92	62.59	1.14	0.04	0.76
% Ketogenic AA of Total AA						
Initial	11.81	11.09	11.41	0.57	0.62	0.47
Final	10.87	12.57	13.58	0.52	0.01	0.60
% Branched-chain AA of Total AA						
Initial	36.35	35.97	35.58	1.03	0.60	0.996
Final	36.66	41.53	44.21	0.62	< 0.01	0.16
% Urea Cycle AA of Total AA						
Initial	9.98	9.40	8.75	0.47	0.08	0.95
Final	10.04	10.73	11.72	0.34	0.01	0.73