Effect of Excess Metabolizable Protein Supplementation from Corn Gluten Meal or Soybean Meal on Plasma Amino Acid Concentrations of Beef Cows Consuming Low Quality Forage

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Summary and Implications

With increased availability of fractionated (de-oiled) coproducts, supplementing excess dietary CP is likely when utilizing these high protein and energy coproducts as an energy source. At this time, the effects of these excessive CP diets on beef cow reproduction have not been extensively studied. In addition, the effects consuming excess dietary CP from feedstuffs that differ in rumen degradability with low quality forage on plasma amino acid concentrations of cows have not been extensively characterized. As part of a larger study analyzing the effects of diets containing 150% of metabolizable protein (MP) requirements from a moderately high (corn gluten meal) or low (soybean meal) rumen undegradable protein (RUP) fraction on ovarian function around the time of ovulation, blood samples were taken near ovulation to evaluate the effects of excess MP on circulating plasma amino acid (AA) concentrations. We observed that cows supplemented with excess CP from sources differing in rumen degradability had similar total circulating AA profiles; however, the relative proportions of each AA were different based on protein source. Based on these data, supplementing excess dietary MP from sources differing in degradability differentially affects circulating plasma AA profiles. However, the mechanisms by which these different AA profiles will alter biological, and specifically, reproductive processes are unknown at this time.

Introduction

It has been hypothesized that feeding diets with high concentrations of distillers grains may result in metabolic and reproductive inefficiency due to excess dietary protein. However, with the emergence of fractionated ethanol coproducts that are more concentrated in protein but with lesser fat than traditional DDGS, determining how excess CP concentrations impact reproduction will become increasingly critical in the next few years.

Previous research in dairy cows has evaluated protein degradability and AA circulation post supplementation. However, AA profiles have not been well characterized in beef cows. When circulating AA profiles of sheep were altered, metabolite pathways were up-regulated, some of which have been linked to interact with ovarian and reproductive functions. Recent findings in our lab have shown that excess dietary CP high in RUP fraction positively impacts ovulatory follicle growth. This could potentially be due to alterations in the amount and type of AA available to the animal. Therefore, research is needed to determine how excess dietary CP from sources differing in rumen degradability affect circulating plasma AA concentrations of beef cows.

The objective of this study was to determine the effects of excess MP supplementation from feedstuffs differing in protein degradability on plasma AA concentrations post-supplementation. We hypothesized that excess MP from a moderately RUP supplement would positively impact ovulatory parameters around ovulation, potentially through altered circulating plasma AA profiles.

Materials and Methods

To study the effects of excess dietary protein source on plasma amino acid parameters, 18 non-pregnant, non-lactating Angus-Simmental mature beef cows were allocated by age, BCS, and BW, and assigned to 1 of 2 diets, differing in rumen degradability of protein (Table 1). Cows were offered ad libitum access to corn stalks and individually supplemented once daily with isocaloric, isonitrogenous supplements, composed primarily of either soybean meal (SBM) or corn gluten meal (CGM), formulated to target an ADG of 1 lb/d and equal 150% of NRC MP requirements.

Diets were fed for a total of 58 days. Preprandial coccygeal blood samples were collected on d 47 of the study and plasma was analyzed for AA profile via Ultra Performance Liquid Chromatography. Data were analyzed using PROC MIXED of SAS.

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

	Treatment	
	SBM	CGM
Dry matter intake, lb/d		
Corn silage	0.57	1.02
Corn gluten meal (62% RUP)	---	2.3
Soybean meal (36% RUP)	2.92	----
Mineral	0.25	0.25
Calculated nutrient intake		
Total CP, lb/d	1.62	1.65
Total RUP, lb/d	0.58	0.99
NEg, Mcal/d	2.14	2.3

Results and Discussion

Total plasma AA, essential AA and branched chain AA concentrations were not different ($P > 0.21$; Table 2) between treatments, yet a shift in several individual circulating AA were observed. The absence of a difference in total circulating plasma AA could be due to both treatments receiving 150% of MP requirements in the diet. When plasma samples were analyzed as a percent of total AA, excess MP supplementation from CGM resulted in greater ($P < 0.05$) circulating concentrations of leucine, phenylalanine, and methionine than SBM supplemented cows. Increased circulation of leucine (a branched-chain AA) has been shown to interact with growth rate of preovulatory follicles by potentially influencing the IGF-1 pathway and increasing follicle growth. Excess MP supplementation from SBM resulted in greater ($P < 0.05$) circulating concentrations of arginine, lysine, threonine, tryptophan and valine compared to CGM supplemented cows. Previous research has shown arginine to affect blood flow through nitric oxide mechanisms, and have the potential to impact ovarian function by increasing blood flow and subsequent hormone secretion.

Based on these data, source of CP when fed in excess has differential impacts on circulating plasma AA profiles which could potentially impact ovarian functions in beef cows. However, the mechanisms by which these AA profiles interact with physiological processes are unknown at this time. Thus, more research is warranted to elucidate how source and amount of CP, when supplemented in low quality forage-based diets, may influence plasma AA profile and subsequent effects on reproductive functions in beef cows.

Table 2. Effects of excess MP supplementation on plasma AA concentrations

	Treatment			
	SBM	**CGM**	**SEM**	***P*-Value**
AA, umol/L[1]				
Total AA	1,573	1,682	83.75	0.37
Essential AA	791.07	829.53	56.23	0.64
Nonessential AA	782.24	852.9	41.95	0.25
Glycogenic AA	939.10	1007	48.26	0.33
Ketogenic AA	207.33	263.02	20.06	**0.07**
Branched-chain AA	660.75	733.7	39.39	0.21
% of Total AA				
Essential AA	49.73	49.34	1.75	0.88
Nonessential AA	50.27	50.66	1.75	0.88
Glycogenic AA	60.21	59.81	1.61	0.86
Ketogenic AA	12.83	15.69	0.74	< **0.01**
Branched-chain AA	41.92	43.68	1.01	0.23
Essential				
% Arginine	5.44	4.34	0.33	**0.03**
% Histidine	3.34	3.47	0.14	0.50
% Isoleucine	5.21	5.03	0.23	0.59
% Leucine	7.59	11.94	0.80	< **0.01**
% Lysine	5.24	3.75	0.40	**0.02**
% Methionine	1.15	1.33	0.05	**0.03**
% Phenylalanine	3.10	4.02	0.25	**0.02**
% Threonine	3.49	2.58	0.30	**0.05**
% Tryptophan	2.09	1.39	0.21	**0.03**
% Valine	13.08	11.47	0.54	**0.05**
Nonessential				
% Alanine	9.99	10.36	0.58	0.66
% Asparagine	1.68	1.90	0.08	**0.05**
% Aspartate	0.33	0.37	0.02	0.19
% Glutamate	4.02	4.01	0.22	0.99
% Glutamine	16.04	15.23	0.62	0.37
% Glycine	11.55	10.64	0.96	0.51
% Proline	3.33	4.53	0.24	< **0.01**
% Serine	3.35	3.62	0.13	0.17
Percent of Essential AA				
% Arginine	11.02	8.86	0.69	**0.04**
% Histidine	6.77	7.02	0.23	0.45
% Isoleucine	10.51	10.18	0.30	0.46
% Leucine	15.20	24.21	1.39	< **0.01**
% Lysine	10.49	7.62	0.73	**0.02**
% Methionine	2.33	2.72	0.12	**0.03**
% Phenylalanine	6.29	8.18	0.51	**0.02**
% Threonine	6.88	5.19	0.46	**0.02**
% Tryptophan	4.17	2.81	0.33	**0.01**
% Valine	26.34	23.20	0.61	< **0.01**

[1]Cysteine and Tyrosine are not presented as were not present in detectable concentrations.