Effects of Supplementing Excess Amounts of Metabolizable Protein from a Moderately Abundant Rumen Undegradable Source on Ovarian Function of Beef Cows Consuming Low Quality Forage

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Summary and Implications

The effects of pairing a low quality forage with excess amounts of metabolizable protein (MP) supplementation from a moderately abundant rumen undegradable protein (RUP) source (corn gluten meal; 62% RUP) on ovarian function of beef cows was evaluated in a 60-day trial. Non-pregnant, non-lactating cows (n = 16) were offered ad libitum access to cornstalks and fed 1 of 2 isocaloric diets (0.48 NE_m/lb) and supplemented primarily with corn gluten meal to provide 125% MP requirements (MP125) or 150% MP requirements (MP150). It was observed that cows offered MP at 150% in the diet from a moderately abundant RUP source had increased ovulatory follicle diameter, average antral follicle count and corpus luteum (CL) development compared to 125% MP. Therefore, excess dietary CP supplementation from a RUP source at 150% of MP requirements appears to enhance ovarian parameters of beef cows when fed with low quality forage compared to supplementation at 125% of MP requirements.

Introduction

Crude protein (CP) supplementation is a common practice with beef cattle producers today, especially in the Midwest where corn coproduct production continues to expand. However, with increased oil extraction occurring during ethanol production, the coproducts are becoming more concentrated in protein. Therefore, when producers are utilizing these de-oiled coproducts as an energy source, CP requirements of cows are often exceeded. The effects of the excess CP supplementation have been studied more extensively in dairy than beef literature; however, excess CP (150% MP) from a moderately rumen undegradable source (corn gluten meal) has been shown to enhance ovarian parameters of beef cows. Yet, more research is warranted to determine if the amount of excess MP supplied from a moderately RUP source will differentially affect ovarian parameters.

The objective of this experiment was to determine if amount of excess dietary protein from a moderately rumen undegradable protein source affects ovarian functions of non-pregnant, non-lactating beef cows consuming a base diet of low quality forage (corn stalks). Based off of previous research, we hypothesized that greater MP supplementation (150% MP) from corn gluten meal would have a positive impact on beef cow reproductive parameters around the time of ovulation, compared to excess MP at a lesser supplementation rate (125%).

Materials and Methods

To study the effects of increasing MP supplementation on ovarian and hormone parameters, non-pregnant, non-lactating mature beef cows (n = 16; BW = 1214 ± 79 lb; BCS = 4.93 ± 0.34; Age = 6.36 ± 2 yr) were allocated by start BW, BCS and age, and assigned to 1 of 2 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 either 125% (MP125) or 150% (MP150) of NRC MP requirements. Dietary supplements were individually delivered once daily for 60 days. The experimental design is located in Figure 1, and diet supplement formulation is located in Table 1.

Twenty days after dietary treatment initiation, cows were synchronized with the 5-day CO-Synch + CIDR protocol. Ten days after ovulation, 100 µg GnRH was again administered to initiate a new follicular wave. From GnRH injection and daily thereafter until ovulation, transrectal ultrasonography was performed to diagram location and size of all antral follicles ≥ 3mm in diameter on both ovaries. Daily ultrasonography was terminated once estrus was detected and a successful ovulation was confirmed by disappearance of the dominant follicle. Seven days after observed estrus, corpus lutem (CL) volume was determined and diets were terminated. Blood samples were collected every other day for metabolite analysis for the duration of the trial. Daily blood samples were collected during the ultrasound period through CL characterization for steroid hormone analysis. Data were analyzed using PROC MIXED of SAS. Cow age and BW change were used as covariates where necessary.

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

	Treatment	
Item	MP125	MP150
Dry matter intake, lb/d		
Corn silage	0.55	0.55
Corn gluten meal (62% RUP)	0.68	1.47
Cracked corn	0.70	---
Mineral	0.24	0.24
Calculated nutrient intake		
CP, lb/d	0.55	1.06
RUP, kg/d	0.81	0.90
NE_m, Mcal/d	1.80	1.83
NE_g, Mcal/d	1.22	1.23

Results and Discussion

As designed, cow BW and BCS did not differ (*P* > 0.73) between treatments at the beginning or end of the experiment. Ovulatory follicle wave characteristics of size at dominance, duration of dominance, growth post dominance, size at spontaneous luteolysis, growth post-luteolysis and duration of proestrus were not different (*P* > 0.11) between treatments. However, cows from the MP150 treatment had greater maximum ovulatory follicle diameter (*P* = 0.04) than MP125 treatment cows. Larger ovulatory follicles could potentially be due to increased RUP altering circulating plasma AA profile, and larger follicles could lead to more competent oocytes and greater fertility. Cows offered MP150 also had greater average antral follicle counts (AFC; *P* = 0.01). Previous research has shown that AFC is primarily influenced by developmental programming. However, this is not the first instance where excess CP has enhanced AFC. Yet, more research will be required to further study CP and AFC effects on fertility. Corpus luteum volume was also greater (*P* < 0.01) in MP150 cows than MP125 treatment cows. As ovulatory follicle diameter and CL volume are correlated, greater CL volume could also enhance probability of pregnancy success.

Although we observed differences in follicle size and CL volumes, peak estradiol and day 7 progesterone concentrations were not different (*P* > 0.25) between treatments. This could potentially be due to the larger follicles being overly mature, making the steroid hormone concentrations similar to smaller follicles from MP125 cows. As expected cows consuming 150% MP had greater plasma urea nitrogen concentrations at ovulation (*P* = 0.04) compared to cows consuming 125% MP. Excess CP consumption leading to PUN concentrations above 19 mg/dL has been associated with infertility in dairy cattle; however, this concentration was not reached in this study and doesn't appear to negatively impact the ovarian parameters measured in beef cows.

In conclusion, supplementing 150% MP from moderately abundant RUP source appears to enhance ovarian reproductive parameters of beef cows consuming low-quality forage. However, further research is needed to determine the impacts on overall fertility.

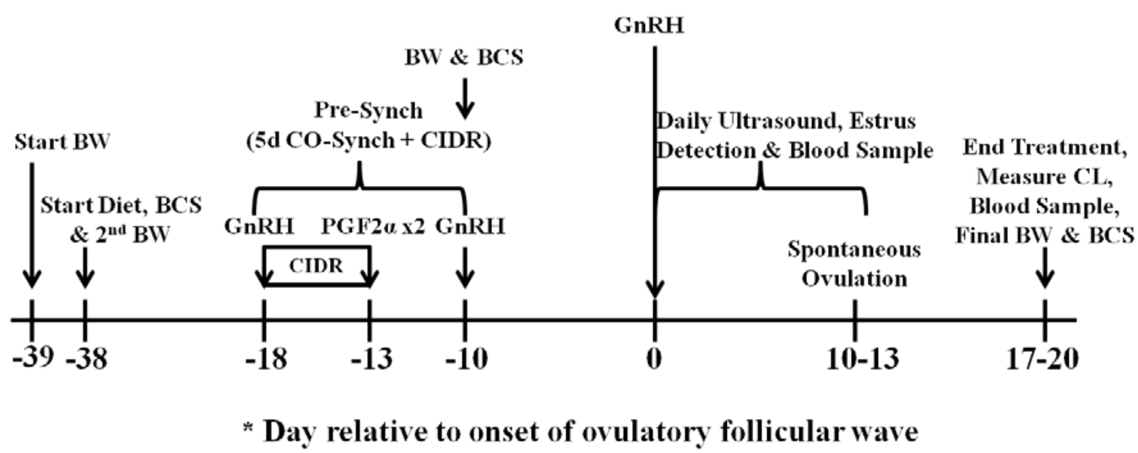

Figure 1. Experimental design.

Table 2. Effects of excess amounts of MP supplementation on BW and BCS performance

	Treatment[1]			
Item	MP125	MP150	SEM	*P*-Value
BW, kg				
Initial	548.81	556.74	16.96	0.74
Final	560.56	551.16	19.57	0.73
BCS[2]				
Initial	4.95	4.90	0.16	0.84
Final	4.84	4.83	0.11	0.99

[1]Treatment included ad libitum access to corn stalks, followed by daily supplementation of MP at 125% (MP125) or 150% (MP150) of NRC MP requirements for non-pregnant, non-lactating multiparous beef cows.
[2]BCS on scale of 1 to 9 (1 = emaciated, 9 = obese; Wagner et al, 1988).

Table 3. Effects of excess amounts of MP supplementation on ovulatory follicle wave, corpus luteum characteristics, steroid hormone and metabolite concentrations

	Treatment[1]			
Item	MP125	MP150	SEM[2]	*P* -Value
Ovulatory follicle size at dominance[3], mm	8.31	8.53	0.32	0.65
Dominance duration[4], d	6.65	6.62	1.27	0.99
Ovulatory follicle growth post-dominance[5], mm	4.37	6.81	0.94	0.11
Dominant follicle size at luteolysis[6], mm	11.58	13.52	1.38	0.40
Dominant follicle growth post-luteolysis, mm	2.37	1.51	0.77	0.54
Proestrus duration[7], h	33.82	45.38	10.43	0.50
Ovulatory follicle diameter, mm	12.60	15.28	0.73	0.04
Maximum secondary follicle diameter, mm	7.90	7.92	0.69	0.99
Follicular wavelength, d	10.73	10.73	0.87	0.99
Total ovarian antral follicle count (AFC)				
Day 1 of wave	19.28	17.26	1.57	0.40
Day 2 of wave	15.43	18.28	1.73	0.29
Day 3 of wave	16.99	18.42	2.10	0.65
Average AFC of entire wave	13.72	16.68	0.62	0.01
Corpus luteum volume 7 d post-estrus, cm^3	1.17	6.08	0.56	< 0.01
Peak estradiol-17β, pg/mL	5.86	6.97	1.10	0.51
Progesterone 7-d post-estrus, ng/mL	2.23	3.39	0.63	0.25
PUN at ovulation, mg/dL	5.94	8.59	0.82	0.04

[1]Treatment included ad libitum access to corn stalks, followed by daily supplementation of MP at 125% (MP125) or 150% (MP150) of NRC MP requirements for non-pregnant, non-lactating multiparous beef cows.
[2] Greater SEM presented (MP125: n = 6; MP150: n = 5).
[3] Dominance obtained when largest growing follicle was at least 1mm larger than any other growing follicle and at least 8mm in diameter.
[4] Period between attainment of dominance until ovulation.
[5] Growth of ovulatory follicle between dominance and ovulation.
[6] Luteolysis defined as first day on which circulating progesterone concentrations were < 1 ng/mL.
[7] Period between luteolysis and expression of estrus.