Effects of fat supplementation among beef cows on postpartum reproductive performance and calf growth

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Summary

Two hundred forty-eight mixed age postpartum beef cows (3 - 10 yr.) were used to evaluate the effect of added protein (PR) or protein plus 10% fat from sunflower oil (PR+FAT), when fed prebreeding, on cow condition change, reproductive performance, and calf growth.

Cow body weight was monitored during the average 36 day prebreeding period when supplements were fed and during the period cow body weight declined across all treatments but did not differ (P=.26). BCS also declined across treatments but did not differ statistically (P=.19).

Based on rib and rump fat measurements, cows in the study had greater fat depth overall during the second year of the study as compared to the first year (P=<.01). For rib fat change during the prebreeding supplementation period, no year (=.50), treatment (P=.20), or year x treatment (P=.08) interactions were identified.

At the rump location, a similar but greater magnitude of response was observed for inclusion of sunflower oil with protein in the supplement. For rump fat change, a year effect (P=.63) was not identified; however, treatment (P=.0005) and year x treatment (P=.01) effects were evident. For year 1, feeding the protein-based supplement during the prebreeding period reduced fat depth change (P=.02) compared to the control group of cows. Fat depth change for the PR+FAT cows, when compared to the control group, did not differ (P=.26). In the second year, when the amount of the protein-based supplement with added fat was increased to balance microbial protein flow, rump fat depth was significantly increased by the start of the breeding season compared to the C (P=<.001) and PR (P=.02) supplemented cows.

Reproductive performance following prebreeding protein or protein plus 10% fat supplementation from sunflower oil was the principal objective of this investigation. First service AI pregnancy rate varied numerically between years, however, ChiSquare analysis for year (P=.39) and treatment (P=.32) did not differ suggesting there was no measurable impact on luteal modulation resulting from supplemental protein or protein plus 10% sunflower oil.

At 21d, a year effect (P=.47) was not identified for supplementation, but supplementation improved pregnancy rate (P=.08). Protein supplementation improved pregnancy rate year 1 and PR+FAT improved pregnancy rate year 2. When AI and 21d pregnancy rate were combined, the effect due to treatment did not differ (P=.36). For 42d pregnancy rate, a significant year effect (p=.001) was observed, but effects due to treatment did not differ (P=.57).

Overall, a year effect for total pregnancy was not observed (P=.68) and supplemental treatment (P=.19)did not improve reproductive efficiency when compared to the all hay control diet.

There were significant year effects for calf growth during the prebreeding period (P<.01), however, treatment advantage was measured for calf end weight (P=.91), weight change (P=.32), or ADG (P=.34).

Introduction

Feeding fat to beef cows after calving as a source of supplemental energy is not a new practice. Fat is a concentrated energy source, containing 2.25 times more energy per unit than either starch or protein. Basic research with added dietary fat of plant origin has resulted in a positive reproductive response independent of caloric effects. Positive ovarian physiological responses include increased follicular growth and function, increased corpus luteum (CL) lifespan, and shortened postpartum interval (Talavera et al., 1991; Thomas et al., 1997; Williams and Stanko, 1999). In a recent review of fat feeding experiments, Hess (2003) concluded that the addition of supplemental fat may increase the percentage of cows exhibiting ovarian luteal activity, but the interval from calving to the first ovulatory estrus, first service conception rate and overall conception rate were not improved.

Considering the variation in response to fat supplementation, a series of investigations have been initiated at the Dickinson Research Extension Center to evaluate sources of fat, to determine reproductive response based on fatty acid composition, and to estimate the economic importance of fat in beef cattle production.

Beginning in 2002, the first in a series of investigations to evaluate fat supplementation was initiated with a study that compared protein supplementation with and without added fat. Protein and fat supplements were fed before and after calving. Fat derived from either tallow or soybean oil was fed from 30 days before calving to 30 days after the last cow calved. Feeding either soybean oil or tallow pre- and postcalving did not improve reproductive performance, however, first service pregnancy rate was numerically higher when unsaturated fat from soybean oil was fed pre- and postcalving (Landblom et al., 2002).

The current project is the second investigation in the series and is designed to evaluate the value of sunflower oil as a nutritional enhancement that may improve reproductive performance in postpartum beef cows.

Procedure

Two hundred forty-eight beef cows ranging in age from 3 to 10 years were used in a randomized complete block design to evaluate the effect of added protein (PR) or protein plus 10% fat from sunflower oil (PR+FAT), fed 33d prebreeding, on reproductive performance and calf growth. .

Weight blocks, based on cow weight, were light, medium, medium-heavy and heavy with pen serving as the experimental unit. The forage fed was medium-quality alfalfa hay, which was fed to all cow groups. Treatments were 1) control cows (C) (n=83) that received hay only after calving, 2) protein supplemented cows (PR) (n=81) received an 18% CP supplement plus medium quality alfalfa hay, 3) 18% CP protein supplement plus 10% fat from sunflower oil (PR+FAT) (n=84) plus medium quality alfalfa hay. For year 1, supplements and hay provided 676 and 594 grams of metabolizable protein per day in excess of NRC (1996) requirements and .31 and .29 Mcal/lb. of net energy for gain for the PR and PR+FAT treatment groups, respectively. For year 2, the amount of supplement delivered was adjusted such that supplement and hay provided 654 and 617grams of metabolizable protein per day in excess of NRC (1996) requirements and .30 and .30 Mcal/lb. of net energy for gain for the PR and PR+FAT treatment groups, respectively.

The first year of the investigation, control cows received 46.8 lbs. of a medium-quality alfalfa hay/head/day and supplemented cows received an average 41.6 lbs. of the same medium-quality alfalfa hay/head/day plus either 6.84 pounds (PR) or 5.02 pounds (PR+FAT) of the experimental test supplements. For year 2, control cows received 46.1 lbs. medium-quality alfalfa hay/head/day and supplemented cows received an average 42.0 lbs. of a similar medium-quality alfalfa hay/head/day plus either 6.45 lbs (PR) or 5.45 lbs (PR+FAT) of the test supplements. The supplements were fed such that the respective diets were isocaloric but not isonitrogenous and were fed in concrete bunks on alternate days. Ingredient composition and nutrient analysis of supplements are shown in Tables 1 and 2. Table 3 defines feed allocation for each experimental diet each year of the study.

Supplement feeding began 33 and 39days before the start of a GnRH/PGF2α synchronized artificial breeding season and ended when breeding began. Ninety days after the start of the AI breeding season all cows were scanned using ultrasound to determine pregnancy and fetal age based on cranial width. Effect of supplementation on reproductive performance was measured for first service AI pregnancy rate, natural service 21d and 42d pregnancy rate, and pregnancy rate overall.

Calf performance was monitored during the prebreeding supplementation period.

Results and Discussion

The effect of supplemental protein or protein plus fat from sunflower oil on postpartum prebreeding cow and calf performance and reproductive performance was evaluated based on changes in body weight and condition score, rib and rump fat depth changes, first service and subsequent heat cycle pregnancy rates and calf growth.

During the average 36day period preceding the start of the breeding season, cow body weight declined across all treatment groups, but did not differ (P=.26)(Table 4).Investigations by Patterson et al. (2003) with 2-yr-old heifers, that grazed dormant winter forage, indicate that metabolizable protein is a better formulation parameter than using the crude protein system because the metabolizable protein system better differentiates between the requirements of ruminal microbes and metabolizable protein requirements of the animal. Using the metabolizable protein system for formulation decisions may be a more useful method for avoiding metabolizable protein deficiencies. As a precaution in the second year of the study, the quantity of PR and PR+FAT supplements delivered were modified to insure that NEg and metabolizable protein balance (protein supply to the small intestine from microbial protein and UIP) were more closely balanced.

Changes in body condition were measured visually and electronically with ultrasound. Body condition score among all cows across treatments declined during the prebreeding period, but did not differ between treatments (P=.19).

Based on rib and rump fat measurements, cows in the study had greater fat depth overall during the second year of the study as compared to the first year (P=<.01).

For rib fat change during the prebreeding supplementation period, no year (=.50), treatment (P=.20), or year x treatment (P=.08) interactions were identified.

Measurement at the rump location provided a similar, but greater magnitude of response for inclusion of sunflower oil with protein in the prebreeding supplement. For rump fat change, a year effect (P=.63) was not identified; however, treatment (P=.0005) and year x treatment (P=.01) effects were evident. For year 1, feeding the protein-based supplement during the prebreeding period reduced fat depth change (P=.02) compared to the control group of cows. Fat depth change for the PR+FAT cows, when compared to the control group, did not differ (P=.26). In the second year, when the amount of the protein-based supplement with added fat was increased to balance microbial protein flow, rump fat depth was significantly increased by the start of the breeding season compared to the C (P=<.001) and PR (P=.02) supplemented cows.

Effect of PR or PR+FAT on reproductive performance has been summarized in Table 6. Compared to unsupplemented control cows, AI pregnancy rate was numerically lower for supplemented cows. In year two, AI pregnancy rate was numerically higher for protein supplemented cows, but overall AI pregnancy rate was not improved due to supplementation (P=.32).

At 21d, a year effect (P=.47) was not identified for supplementation, but supplementation improved pregnancy rate (P=.08). Protein supplementation improved pregnancy rate year 1 and PR+FAT improved pregnancy rate year 2. When AI and 21d pregnancy rates were combined, pregnancy response due to supplementation was improved year one (P=.01), but not year two. Overall combined AI and 21d pregnancy due to treatment did not differ (P=.36). For 42d pregnancy rate, a significant year effect (p=.001) was observed, but effects due to treatment did not differ (P=.57).

Total pregnancy year effect (P=.68) and treatment effect (P=.19) did not differ.

Calf growth during the supplementation period is shown in Table 7. For calf weight change and ADG, there was a significant year effect (P=<.01), but no effect due to treatment (P=.32).

Implication

Providing prebreeding protein or protein plus 10% sunflower oil in daily fed supplements did not improve first service pregnancy rate, combined first service and 21 day pregnancy rate or overall pregnancy rate.

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Table 1. Calculated supplement composition (as fed basis).

Ingredients	Protein	Protein + Fat
Wheat Midds, %	30.017	25.967
Barley Malt Sprouts %	30.0	20.0
Cull Beans, %	20.0	20.0
Sunflower Oil, %	0.0	10.0
Canola Meal, %	5.0	10.0
Distillers Dried Grain, %	3.75	5.0
Molasses, %	4	4.0
Bentonite, %	2.0	2.0
Salt, %	1.75	1.35
Phos. 21%, Dical	1.25	0.0
Calcium Carbonate, %	1.85	1.3
Molastik Binder, %	.2	.2
Trace Mineral Pak, % [a]	.1	.1
Selenium 1600, %	.063	.063
Vitamin Pak, % [b]	.02	.02

[a] Trace Mineral Pak provided: manganese 130ppm, iron 108ppm, copper 68.95ppm, zinc 238ppm, Cobalt 1.13ppm, iodine 5.42ppm, sulfur .22%

[b] Vitamin Pak provided: vit A 16.0 KIU/lb.,vit D-3 1.60 KIU/lb., vit E 16.0 IU/lb., thiamine 2.71 mg/lb.

Table 2. Supplement nutrient analysis (as fed basis).

	Protein	Protein + Fat
Crude Protein, %	18.2	18.11
UIP, %	5.45	5.28
Crude Fat, %	2.64	12.56
ADF, %	9.83	9.18
NDF,%	26.75	23.37
Calcium, %	1.2	.79
Phosphorus, %	.84	.56

Table 3. Prebreeding hay and supplement fed.

	Control	Protein		Protein + Fat	
No. Cows	43	44		42	
Amount/Cow/Day: Yr. 1:					
Alfalfa/Cow/Day, lbs.	46.77	41.69		41.55	
Suppl./Cow/Day, lbs.		6.84		5.02	
Yr. 2:					
Alfalfa/Cow/Day, lbs.	46.1	41.8		42.1	
Suppl./Cow/Day, lbs.		6.45		5.54	
Protein and Energy Bal.:		**Year 1**	**Year 2**	**Year 1**	**Year 2**
Metabolizable Protein, g/d		676	654	594	617
NEg, Mcal/lb.		.31	.30	.29	.30

Table 4. Postcalving cow weight change following 18% CP supplement with or without 10% fat from sunflower oil.

	Control	Protein	Protein + Fat	SE	P-Value
Days on Test	36	36	36		
Cows Age, yrs.	5	4.8	4.7		
Postcalving Cow Wt., lbs.	1239	1240	1232	36.2	.98
Breeding Wt., lbs.	1196	1207	1217	32.3	.90
Cow Wt. Change, lbs.	-43	-33	-15	6.9	.26

Table 5. Summary of postcalving BCS change and ultrasound fat depth change.

		Control	Protein	Protein + Fat	P-Value Year	P-Value Trmt	P-Value Yr x Trmt
BCS (visual):							
BCS Change	- Yr 1	-.40	-.11	-.09	.33	.19	.37
	- Yr 2	-.52	-.85	-.41			
Fat Depth (ultrasound):							
Rib:							
Rib Fat Change, mm	- Yr 1	-.38	0.0	-.28	.50	.20	.08
	- Yr 2	-.31	-.42	.52			
Rump:							
Rump Fat Change, mm	- Yr 1	-.74[a]	.17[b]	-.32[ab]	.63	.0005	.01
	- Yr 2	-1.17[x]	-.18[y]	.77[z]			

Table 6. Breeding cycle pregnancy rate.

		Control	Protein	Protein + Fat	Pr > ChiSq Year	Pr > ChiSq Trmt
Pregnancy Rate:						
AI, %	- Yr 1	44.2	21.4	31.8	.39	.32
	- Yr 2	37.5	48.7	27.5		
21d, %	- Yr 1	34.9	64.3	56.8	.47	.077
	- Yr 2	57.5[b]	41.0[c]	70.0[a]		
Combined 21d	- Yr 1	79.1	85.7	88.6	.01	.36
	- Yr 2	95.0	89.7	97.5		
42d, %	- Yr 1	11.6	7.4	9.3	.001	.57
	- Yr 2	2.5	0.0	0.0		
Overall Preg. Rate	- Yr 1	90.7	93.1	97.9	.68	.19
	- Yr 2	97.5	89.7	97.5		
Open, %	- Yr 1	9.3	6.9	2.1	<.01	.33
	- Yr 2	2.5	10.3	2.5		

[a] Ultrasound cranial measurements and regression analysis were used to compute fetal age following measurement taken 90 days after insemination. Means with unlike superscripts differ significantly.

Table 7. Calf growth following cow supplementation of an 18% CP supplement with or without 10% fat from sunflower oil.

		Control	Protein	Protein + Fat	P-Value Year	Trmt	Yr x Trmt
Calf Start Wt., lbs.	-Yr 1	165	163	157	.29	.91	.68
	-Yr 2	172	165	179			
Calf End Wt., lbs.	-Yr 1	222	221	223	<.001	.91	.88
	- Yr 2	252	261	257			
Calf Wt. Change, lbs.	-Yr 1	57[a]	58[a]	66[b]	<.001	.32	>.10
	- Yr 2	80	96	78			
Calf ADG, lbs.	-Yr 1	1.6	1.7	1.9	<.01	.34	.10
	-Yr 2	2.0	2.4	1.9			

Means with unlike superscripts differ significantly.