Bypass supplementation of grazing pregnant beef cows
by Jess Lee Miner

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal Science
Montana State University

Abstract:
The objective was to determine if supplementing additional rumen-bypass protein vs only an oil-seed meal could reduce prepart urn weight loss. Other objectives were to determine the effects of supplement (S) on forage digestibility, ad libitum intake and blood metabolite concentrations. During two winters (trials 1 and 2) approximately 60 prepartum beef cows were grazed on native foothills range. Cows were randomly allotted to five S groups and supplemented on alternate days in early afternoon with either (g/d): none (control) 570 soybean meal (SOY); 450 soybean meal and 230 blood meal (SOY+BM); 140 soybean meal, 16 urea and 450 corn gluten meal (SOY+COM) or 570 soybean meal and 210 animal fat (SOY+FAT). Palpable condition scores and body weights were determined at trial initiation (mid-December) and ending (early March). Each month (sampling period) neutral detergent fiber (NDF) fermentation rate of grazed forage was measured via nylon bags. Cobalt EDTA and Cr mordant were used to measure ruminal fluid and particulate mass and dilution rate. At the intervals nylon bags were removed, blood samples were obtained and ruminal ammonia and pH were measured with a meter. Serum was analyzed for concentration of glucose, albumin, total protein, urea nitrogen, total bilirubin, creatinine, cholesterol and amino acids. Cows in control gained the least (P<.01) body weight in both trials 1 (-1.9 kg) and 2 (-46.4 kg). Additional bypass protein increased (P=.06) weight gain of SOY+BM (-1.8 kg) and SOY+CGM (-15.0 kg) compared to SOY (-20.1 kg) in trial 2. Except for cholesterol blood metabolites were not affected by S but the interaction with period was often significant. For example, during cold temperatures and snow cover bilirubin was elevated most in control and least in SOY+BM. Fermentation rate was increased (P<.01) by supplementation in trial 1. It was higher (P=.07) for SOY+BM (2.6%/h) and S0Y+.CGM (2.8%/h) than for SOY (2.3%/h). Fermentation rate was not influenced by S in trial 2 but the same trends were observed. Ruminal pH was lower (P=.03) for SOY than control in trial 1 and lower for SOY+BM and SOY+OGM than for SOY in trials 1 (P=.01) and 2 (P=.09). Ruminal ammonia was lowest (P=.03) in control but not different between other S groups. Fluid dilution rate was lower and volume higher for SOY+BM and SOY+CGM than SOY in both trials 1 (P<.06) and 2 (P<.14). Particulate dilution rate followed the same trend (P=.03). Bypass protein additions to rumert-degradable protein supplement can reduce prepartum weight loss of grazing cows. In addition, bypass protein can enhance NDF fermentation and increase ruminal retention time. Cows supplemented with SOY plus bypass protein were least affected by changes in environment as indicated by blood metabolites.

BYPASS SUPPLEMENTATION OF GRAZING PREGNANT BEEF COWS

by

Jess Lee Miner

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Animal Science

MONTANA STATE UNIVERSITY
Bozeman, Montana

November 1986

APPROVAL

of a thesis submitted by

Jess Lee Miner

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date December 5, 1986

ACKNOWLEDGEMENTS

The investigations herein represent the influence of several scientists, instructors, graduate students and relatives. Individuals of particular significance are Mr. and Mrs. Russell Miner for showing me how to work; Drs. Mark Petersen, Kris Havstad, Michael McInerney, James Berardinelli and Robert Bellows. Their contributions are sincerely appreciated.

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ABSTRACT

The objective was to determine if supplementing additional rumen-bypass protein vs only an oil-seed meal could reduce prepartum weight loss. Other objectives were to determine the effects of supplement (S) on forage digestibility, ad libitum intake and blood metabolite concentrations. During two winters (trials 1 and 2) approximately 60 prepartum beef cows were grazed on native foothills range. Cows were randomly allotted to five S groups and supplemented on alternate days in early afternoon with either (g/d): none (control) 570 soybean meal (SOY); 450 soybean meal and 230 blood meal (SOY+BM); 140 soybean meal, 16 urea and 450 corn gluten meal (SOY+CGM) or 570 soybean meal and 210 animal fat (SOY+FAT). Palpable condition scores and body weights were determined at trial initiation (mid-December) and ending (early March). Each month (sampling period) neutral detergent fiber (NDF) fermentation rate of grazed forage was measured via nylon bags. Cobalt EDTA and Cr mordant were used to measure ruminal fluid and particulate mass and dilution rate. At the intervals nylon bags were removed, blood samples were obtained and ruminal ammonia and pH were measured with a meter. Serum was analyzed for concentration of glucose, albumin, total protein, urea nitrogen, total bilirubin, creatinine, cholesterol and amino acids. Cows in control gained the least (P<.01) body weight in both trials 1 (-1.9 kg) and 2 (-46.4 kg). Additional bypass protein increased (P=.06) weight gain of SOY+BM (-1.8 kg) and SOY+CGM (-15.0 kg) compared to SOY (-20.1 kg) in trial 2. Except for cholesterol blood metabolites were not affected by S but the interaction with period was often significant. For example, during cold temperatures and snow cover bilirubin was elevated most in control and least in SOY+BM. Fermentation rate was increased (P<.01) by supplementation in trial 1. It was higher (P=.07) for SOY+BM (2.6%/h) and SOY+CGM (2.8%/h) than for SOY (2.3%/h). Fermentation rate was not influenced by S in trial 2 but the same trends were observed. Ruminal pH was lower (P=.03) for SOY than control in trial 1 and lower for SOY+BM and SOY+CGM than for SOY in trials 1 (P=.01) and 2 (P=.09). Ruminal ammonia was lowest (P=.03) in control but not different between other S groups. Fluid dilution rate was lower and volume higher for SOY+BM and SOY+CGM than SOY in both trials 1 (P<.06) and 2 (P<.14). Particulate dilution rate followed the same trend (P=.03). Bypass protein additions to rumen-degradable protein supplement can reduce prepartum weight loss of grazing cows. In addition, bypass protein can enhance NDF fermentation and increase ruminal retention time. Cows supplemented with SOY plus bypass protein were least affected by changes in environment as indicated by blood metabolites.

INTRODUCTION

The nutrient concentration (digestible energy, crude protein, vitamin and mineral content) of forage normally declines with maturity. In Montana during the winter months dormant forage alone usually does not provide adequate nutrition to maintain body weight in gestating beef cows. Forage can be harvested during times of high quality and stored for winter feed. However, at times standing forage is physically or economically prohibitive to harvest. Since standing forage is often exposed for grazing, it is usually less expensive to harvest by grazing and supplement those nutrients deficient in the forage.

To date, the primary objective of supplementing winter grazing has been to feed nutrients deficient in the forage. However, supplement has also been shown to affect forage intake (Siebert and Hunter, 1981) and grazing behavior (Adams, 1985).

Responses to protein supplementation are common. However, it is not known whether the effect occurs due to enhanced microbial nutrition in the rumen or due to increased supply of amino acids presented to the small intestine. Providing additional protein which is primarily digested in the small intestine (rumen-bypass) has increased growth rate of calves (Klopfenstein et al., 1978). The value of bypass protein for gestating beef cows has not been established. The objective of this study was to determine if supplementing additional rumen-bypass protein vs only an oil-seed meal could reduce prepartum weight and condition loss and thus have a probable impact on postpartum interval. Other objectives were to determine the effect of rumen-degradable protein with or without additional bypass protein on factors related to digestibility, ad libitum intake and blood metabolite concentrations.

LITERATURE REVIEW

Effect of Prepartum Nutrition on Reproduction

The most important factor reducing net calf crop is failure of cows to become pregnant (Dziuk and Bellows, 1983). The time between parturition and first estrus, (postpartum interval) is highly correlated with preparatum energy intake (Wiltbank et al., 1962; Dunn et al., 1969; Clanton and Zimmerman, 1970; Bellows and Short, 1978; Bellows et al., 1982). In contrast, Phillips and Vavra (1981) did not find an effect of prepartum energy consumption on postpartum interval. However, they fed gestating cows at 120, 100 and 80% of NRC (1976) energy recommendations, whereas the aforementioned investigators limited energy intake to 50-60% of NRC (1976) recommendations. Thus, it seems that once the energy requirement is met, increasing energy consumption does not shorten postpartum interval. Postpartum interval has also been shortened by increasing postpartum energy consumption, but this effect seems less important than the prepartum energy effect (Wiltbank et al., 1962; Dunn et al., 1969). In fact, Bellows and Short (1978) found lengthened postpartum intervals in cows fed at a high energy level vs low energy level postpartum when prepartum energy consumption was deficient. They hypothesized that the high postpartum energy consumption stimulated milk production which in turn increased postpartum interval.

Bellows and Short (1978) found that shortened postpartum interval was related to decreases in precalving condition score loss and to a lesser extent related to decreases in precalving body weight loss. Clanton and Zimmerman (1970) found that in situations where protein intake was low, a higher energy intake did not increase weight gain in prepartum heifers. They also found no effect from increased protein intake when energy consumption was low and concluded that the first limiting nutrient should be supplemented first.

Need for Supplement

Cordova et al. (1978) and Allison (1985) state that consumption of available protein and energy by prepartum cows grazing winter range is usually below NRC (1976) recommendations by such magnitude that subsequent reproduction is impaired. Although energy- and(or) protein-dense supplements are readily consumed and can preclude lengthened postpartum interval, their cost compared to that of the grazed forage reduces the attractiveness of supplementation.

Supplement Effect on Intake

In addition to increasing specific nutrient consumption, supplements have been shown to affect intake of forage as reviewed in Table 1 and by Allison (1985) and Siebert and Hunter (1981) and to affect grazing activity (Adams, 1985; Adams et al., 1986). It is generally accepted that high energy supplements derived from grain sources depress voluntary forage intake while supplements rich in natural protein enhance forage intake and digestibility. Causes for the effect of supplemental energy on intake and digestibility are not clear and since these are not directly involved with my objectives will not be discussed. The effect of protein supplements on intake and digestibility probably involves increased rumen microbial activity (Allison, 1985) or decreased retention time (Siebert and Hunter, 1981). Exceptions to this trend can be expected when forage crude protein content is above 8 to 10% (Mison, 1985).

Although Table 1 can be summarized in a variety of ways, it appears that energy supplements depressed forage intake in over half the cases, natural protein supplements of high ruminal degradability increased intake in 11 of 17 cases, urea enhanced intake in 4 of 4 cases, and bypass protein increased intake in all 10 cases reviewed.

Table 1. Forage Intake as Influenced by Protein or Energy Supplementation.

Investigator	Animals	Methods	Time Supplement Fed	Basal Diet	Supplement Per Day	Daily Forage Intake
Branine and Galyean, 1985/ New Mexico	307 kg steers	YB/IVOMD	1000 daily	summer blue grama OM basis: 13.0% CP 38.5% ADIN 80.6% NDF 53.7% ADF 13.8% ADL 14.6% Ash	None	1.63% BW (OM)
					.5 kg corn	2.53% BW (OM)
					1.0 kg corn	1.35% BW (OM)
Branine et al., 1985/ New Mexico	332 kg steers	direct		prairie hay 7.5% CP 12.9% ADIN 64.3% NDF 40.9% ADF 5.3% ADL 9.3% Ash	None	2.33% BW
					.72 kg cottonseed meal	2.27% BW
Kartchner, 1981/ Montana	mature beef cows	Cr_2O_3/ ADL	alternate days	winter range 6.0% CP 57.2% IVDMD 47.9% ADF 5.3% ADL	None	84.1 g DM/ kg $BW^{.75}$
					.75 kg cottonseed meal	80.0 g DM/ kg $BW^{.75}$
					1.70 kg barley	78.5 g DM/ kg $BW^{.75}$
	mature beef cows		three times/wk	winter range 8.1% CP 49.3% IVDMD 51.1% ADF 9.4% ADL	None	66.2 g DM/ kg $BW^{.75}$
					.71 kg soybean meal	76.8 g DM/ kg $BW^{.75}$
					.66 kg barley	63.6 g DM/ kg $BW^{.75}$

Table 1. continued

Investigator	Animals	Methods	Time Supplement Fed	Basal Diet	Supplement Per Day	Daily Forage Intake
Adams et al., 1986/ Montana	3-and 6-year-old beef cows	Cr_2O_3 ADL		winter range 52.3% DMD (ADL)	None	2.0% BW
				48.7% DMD		1.8% BW
Adams, 1985/ Montana	291 kg steers	IVDMD		Russian wild ryegrass	None	3.1% BW
			0730 daily	6.6% CP 62.5% IVDMD	.3 kg corn	2.6% BW
			1330 daily	47.8% ADF 5.1% ADL	.3 kg corn	2.9% BW
Turner et al., 1983/ Montana	3- and 4-year-old beef cows	Cr_2O_3/ IVOMD	three times/wk	winter range	None	1.1% BW
					.91 kg (15% CP)	1.2% BW
					.91 kg (30% CP)	1.4% BW
					1.81 kg (15% CP)	1.7% BW
					None	1.2% BW
					.91 kg (15% CP)	1.3% BW
					.91 kg (30% CP)	1.2% BW
					1.81 kg (15% CP)	1.3% BW

Table 1. continued

Investigator	Animals	Methods	Time Supplement Fed	Basal Diet	Supplement Per Day	Daily Forage Intake
Gill and England, 1984/ England	119 kg Friesian steers	direct	supplement mixed with forage	ryegrass silage 10.3% CP 39.0% Cellulose 6.0% ash	None	1.9% BW (DM)
					50 g fishmeal/ kg silage DM	2.0% BW (DM)
					63 g ground-nut meal/kg DM	2.0% BW (DM)
Hovell et al., 1986/ England	40 kg wether lambs	direct		chopped hay 5.2% CP 59.0% IVOMD 66.0% NDF 40.0% ADF 5.9% ADL 7.0% ash	all hays equalized to 11.6% CP with urea additions	71 g DM/ kg $BW^{.75}$
				chopped hay 9.6% CP 49.0% IVOMD 74.0% NDF 41.0% ADF 7.6% ADL 6.0% ash		62 g DM/ kg $BW^{.75}$
				chopped hay 9.3% CP 39.0% IVOMD 76.0% NDF 45.0% ADF 8.0% ADL 7.0% ash		52 g DM/ kg $BW^{.75}$

Table 1. continued

Investigator	Animals	Methods	Time Supplement Fed	Basal Diet	Supplement Per Day	Daily Forage Intake
				chopped hay 8.6% CP 28.0% IVOMD 75.0% NDF 46.0% ADF 9.0% ADL 10.0% ash		45 g DM/kg $BW^{.75}$
Rittenhouse et al., 1970/ Nebraska	295-620 kg cattle	Cr_2O_3/ ADL	daily	sandhills winter range 5.3% CP 42.0% DMD	soybean meal/ corn/corn starch mixes to provide daily:	
					MCal DE/kg $BW^{.75}$ / g CP/kg $BW^{.75}$	g/kg $BW^{.75}$
					None / None	51
					.020 / 1.16	46
					.041 / 1.16	49
					.061 / 1.16	44
					.081 / 1.16	37
					.020 / 2.07	47
					.041 / 2.07	48
					.061 / 2.07	40
					.081 / 2.07	50
					.020 / 3.00	50
					.041 / 3.00	52
					.061 / 3.00	44
					.081 / 3.00	45

Table 1. continued

Investigator	Animals	Methods	Time Supplement Fed	Basal Diet	Supplement Per Day	Daily Forage Intake
Mullins et al., 1983/ Australia	215 kg steers	direct	daily	prairie hay 2.5% CP	None	1.0% BW
					188 g CP from urea	1.6% BW
					188 g CP from urea/231 g CP from HCHO-cottonseed meal	1.9% BW
					431 g CP from urea & 231 g CP from HCHO-cottonseed meal & 400 g maize	1.7% BW
Hennessy et al., 1983/ Australia	142 kg Hereford steers	direct	twice daily	pasture hay 3.9% CP 41.0% IVOMD 8.0% Ash	cottonseed, meat & fish meal; pelleted kg/d — sorghum grain kg/d	
					None — None	2.0% BW
					.6 — None	2.6% BW
					1.2 — None	2.9% BW
					None — .56	1.4% BW
					None — 1.12	1.6% BW
					.6 — .56	2.6% BW
					.6 — 1.12	2.5% BW
					1.2 — .56	2.2% BW
					1.2 — 1.12	2.2% BW