EFFECTS OF LACTATIONAL STATUS ON FORAGE INTAKE, DIGESTIBILITY AND PARTICULATE PASSAGE RATE OF BEEF COWS SUPPLEMENTED WITH SOYBEAN MEAL, WHEAT MIDDLINGS AND CORN/SOYBEAN MEAL

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Story in Brief

Sixteen mature lactating and 16 early pregnant Hereford and Angus x Hereford beef cows were used to determine effects of different supplements and lactational status on forage intake, digestibility and particulate passage rate. Supplement treatments were: control or equal daily amounts of protein from soybean meal, wheat middlings or a blend of corn/soybean meal. Cows fed soybean meal consumed more hay dry matter and had greater hay digestibility than cows on all other treatments. Mean hay intake (pounds hay/pound body weight) was 1.93, 2.16, 1.91 and 1.88% while hay dry matter digestibility was 52.2, 60.7, 55.2 and 52.7% for control, soybean meal, wheat middlings and corn/soybean meal supplements, respectively. Passage rate was 3.18, 3.58, 3.68 and 3.72% per hour for the same treatments. Lactating cows consumed more hay dry matter (2.11 versus 1.86 pounds hay/pound body weight) than nonlactating cows but hay dry matter digestibility (54.9 versus 55.5%) and particulate passage rate (3.46 versus 3.62% per hour) were not affected by lactational status. No interaction was observed between lactational status and supplement type for hay dry matter intake, digestibility or particulate passage rate. There appears to be no effect of physiological status on utilization of protein or energy supplements when nonlactating cows are nonpregnant or in early gestation.

(Key Words: Cows, Lactation, Wheat Middlings, Supplementation, Forage Intake.)

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Introduction

Wheat middlings (WM) are a by-product of the flour milling industry made up of fine particles of wheat bran, wheat shorts, wheat germ, wheat flour and some of the offal from the tail of the mill. Wheat middlings contain approximately 16% crude protein (CP) and a maximum of 9.5% fiber (AAFCO, 1987). In studies with pregnant, nonlactating spring calving cows, Lusby and Wettemann (1988b) and Cox et al. (1989) found significant increases in weight gains from November to calving when WM were fed at isonitrogenous levels to soybean meal (SBM). After calving however, cow weight changes were similar for SBM and WM. When the same supplements were fed throughout the winter to lactating, fall calving cows (Lusby and Wettemann, 1988a; Ovenell et al., 1989) weight changes were similar for SBM- and WM-supplemented cows, in agreement with results from spring calving cows following parturition. These studies suggest that weight change responses for protein and energy supplements may differ with lactational status. Results from numerous studies indicate that moderate protein, high fiber energy sources have more favorable effects on forage intake and digestibility than energy supplements. The objective of this study was to compare effects of SBM, WM and corn/SBM supplements on forage intake, digestibility and particulate passage rate in lactating and nonlactating cows.

Materials and Methods

Sixteen lactating and 16 nonlactating early pregnant Hereford and Hereford x Angus cows were individually fed prairie hay plus supplement for three 10-day periods for a total of 24 observations on each of four treatments. In period one, cows were randomly allotted within breed, age, body weight and condition and pregnancy status to four treatment groups. In periods two and three, cows were realloted by the above criteria plus previous treatment, so that each cow was on three of the four treatments. Treatments were control (no supplement), SBM, WM and corn/SBM. Supplement composition, amount fed and chemical composition of supplements are presented in Tables 1 and 2. Supplements were fed once daily and provided equal daily amounts of supplemental CP. A 50:50 mixture of salt and dicalcium phosphate was provided free choice to all cows. Cows were housed individually with ad libitum access to prairie hay for 6 h/day.

Voluntary intake of hay was measured directly for 10 days following a 7-day adaptation to supplements. Fecal output was estimated using chromic oxide (Cr at .02 lb/day) as an indigestible marker. Chromic oxide was mixed with ground corn at a concentration of .02 lb per .25 lb of corn and fed with the supplements (.5 lb WM to control cows) once daily from day 1 through

Table 1. Supplement composition and amounts fed (DM basis).

	Control (no supp.)	Soybean meal	Wheat middlings	Corn/ soybean meal
Ingredients, %:				
Soybean meal		90.8		21.9
Wheat middlings			98.2	
Corn, ground				76.3
Dicalcium phosphate		7.7		1.8
Limestone			1.7	
Potassium chloride		1.5		
Amount fed, lb/day[a]		3.0	7.5	7.5
Nutrients supplied per day[b]				
CP from supp., lb	0	1.2	1.2	1.2
ME, Mcal/day[c]	17.0	26.0	27.3	26.2
ME, Mcal/lb BW[d]	1.6	2.5	2.6	2.5
TDN, lb (expected)[e]	10.3	13.7	14.8	15.9
TDN, lb (observed)[f]	10.3	15.8	16.6	15.9

[a] As-fed basis.
[b] Hay included in all calculations.
[c] ME = .82(DDMI · 2 Mcal/lb). ME = metabolizable energy; DDMI = daily dry matter intake.
[d] Total ME/constant BW (1034 lb).
[e] Total Digestible Nutrients (TDN). NRC, 1984.
[f] Total ME/1.645. NRC, 1984.

Table 2. Chemical composition (% of DM) of supplements and prairie hay.

Item[a]	Hay	Soybean meal	Wheat middlings	Corn/ soybean meal
Dry matter	93.5	92.2	90.1	90.8
Ash	-	15.5	7.2	4.8
Crude protein	4.9	43.3	17.3	17.3
Neutral detergent fiber	77.6	10.2	38.7	43.6
Acid detergent fiber	46.6	8.1	8.0	4.7
Starch	-	0	13.1	29.6
Crude fiber	-	5.2	7.7	3.2

[a] Actual chemical analyses.

day 13 of each period. Fecal grab samples were obtained at 8 a.m. and 4 p.m. from day 10 to day 14, composited and used to estimate digestibility. Samples were obtained at 24, 36, 48, 60, 72 and 96 h after terminating Cr dosing to determine particulate passage rate based on the decline in Cr concentration of fecal DM. Total feces were collected from Hereford and Angus x Hereford steers fed prairie hay (ad libitum) and 3 lb WM (five steers in periods one and two and four in period three) to determine marker recovery. Feces were obtained during the same time cows were being sampled.

Hay and supplement samples were analyzed for CP, neutral detergent fiber and acid detergent fiber. Fecal Cr concentrations were determined by atomic absorption spectrophotometry. Fecal output was calculated from Cr concentration and was corrected for Cr recovery which averaged 90.0, 95.3 and 92.3% for periods one, two and three, respectively. Particulate passage rate was estimated by regressing the natural logarithm of fecal Cr concentration against time following withdrawal of Cr from the diet.

Data were analyzed by least squares analysis of variance with a model that included treatment, cow (within lactational status), period, lactational status and a lactational status by treatment interaction. Since there was no interaction, the model was modified to analyze differences between treatments and included cow, period and treatment. Data were pooled across periods for analysis as there was no interaction between period and treatment or lactational status. The least significant difference technique was used to determine differences in means ($P<.05$).

Results and Discussion

Intake, digestibility, particulate passage rate and fecal output measurements are shown in Table 3. Soybean meal supplementation increased ($P<.001$) both hay DM intake and digestibility ($P<.01$) compared with other supplements. Supplementation increased ($P<.001$) total diet DM digestibility (supplement + hay) but no differences between supplements were noted. Fleck et al. (1988) reported that hay DM intake and digestibility were higher for SBM than corn gluten feed supplements. When low-quality forages are supplemented with a high-protein, oilseed meal-based supplement, forage intake and utilization usually increases.

Hay DM intake and DM digestibility tended to be greater for WM than corn/SBM, possibly because of the lower starch content of WM. The supplements used in this study contained 29.6, 13.1 and 0% starch for corn/SBM, WM and SBM, respectively. High levels of starch generally decrease forage intake and digestibility (Fleck et al., 1988). Increased starch in the diet decreases ruminal pH, thus having a detrimental effect on

Table 3. Least squares means for voluntary forage intake, forage digestibility and particulate passage rate.

	Treatment			
	Control (no supp.)	Soybean meal	Wheat middlings	Corn/ soybean meal
Cow weight, lb	1038	1030	1036	1032
Hay DM intake				
Amount, lb/d	20.0[a]	22.2[b]	19.8[a]	19.4[a]
% of body weight/d	1.93[a]	2.16[b]	1.91[a]	1.88[a]
DM digestibility, %				
Hay	52.2[a]	60.7[b]	55.2[a]	52.7[a]
Total	52.2[a]	63.3[b]	62.4[b]	60.7[b]
Particulate flow rate, %/h	3.18[a]	3.58[b]	3.68[b]	3.72[b]
Fecal DM output, lb/day				
Hay	9.7	8.8	8.8	9.2
Total	9.7	9.2	9.9	10.3

[a,b] Means in the same row with different superscripts differ ($P<.01$).

cellulolytic bacteria. Also, it has been suggested that starch alters fiber digestion by increasing digestion lag time. Particulate passage rate was lowest ($P<.01$) for cows on the control diet but not different among cows being fed other supplements. Cows fed supplements with greater amounts of starch had ($P<.09$) faster passage rates. Increased lag time for WM and corn/SBM supplements as compared to SBM may partially explain the lower hay DM intake and digestibility noted.

Studies by Cox et al. (1989) and Lusby and Wettemann (1988b) indicate that cow performance is similar for cows fed WM or SBM supplements following parturition but beneficial effects of additional energy from WM on cow weight and condition changes occur before calving. Lusby and Wettemann (1988b) reported similar performance for cows fed WM and corn/SBM supplements indicating that the greater fiber content and lower energy content of WM compared to corn/SBM can be apparently offset by more favorable effects on forage intake and/or digestibility.

Results of forage intake, digestibility, particulate passage rate and fecal output measurements of lactating vs nonlactating cows are shown in Table 4. Hay DM intake and fecal output were greater ($P<.05$) for lactating than nonlactating cows. Many dairy researchers have reported greater DM intake

Table 4. Voluntary forage intake, forage digestibility and particulate passage rates of lactating and nonlactating cows.

	Lactating	Nonlactating
Hay DM intake		
Amount, lb/day	20.9[a]	20.0[b]
% of body weight/day	2.11[a]	1.86[b]
DM digestibility, %		
Hay	54.9	55.5
Total	59.4	59.9
Particulate flow rate, %/h	3.46	3.62
Fecal DM output, lb/day		
Hay	9.5[c]	8.8[d]
Total	10.1[c]	9.5[d]

[a,b] Means in the same row with different superscripts differ (P<.01).
[c,d] Means in the same row with different superscripts differ (P<.05).

by lactating vs nonlactating cows. Increased intake during lactation may be a function of metabolic changes and/or hypertrophy of the digestive tract.

Hay DM digestibility and particulate passage rate were similar for both lactating and nonlactating cows. There was no supplement by lactational status interaction (P>.50). Results of this study do not explain why cow weight changes were different for nonlactating and lactating cows fed SBM or WM supplements on winter range. In pasture trials by Lusby and Wettemann (1988b) and Cox et al. (1989) cows were in the last trimester of gestation while nonlactating cows used for the intake and digestion study were in early pregnancy. Digestive kinetics of the cow would not be expected to be affected by the fetus during early gestation.

In conclusion, WM appear to be utilized by cows with an efficiency at least equal to that found for an isonitrogenous supplement of corn and SBM. While lactating cows consume more forage than nonlactating cows, there appears to be no effect of physiological status on utilization of protein or energy supplements when nonlactating cows are nonpregnant or in early gestation.

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