Influence of Forage Type, Ratio of Forage to Concentrate, and Methionine Hydroxy Analog on Performance of Dairy Cows[1]

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ABSTRACT

In a 2-yr study, 44 primiparous and 77 multiparous cows were assigned to one of 12 dietary treatments (2 × 3 × 2 factorial). Treatments were two forages (alfalfa or smooth bromegrass), three percentages of grain (40, 50, or 60% of diet DM), and two percentages of methionine hydroxy analog (0 or .15% of diet DM). Feeds were offered as total mixed diets. Data collection began 4 d postpartum and continued through 116 d postpartum. Dry matter intake was not affected by percentage of concentrate or forage source even though NDF of the diets ranged from 25.6 to 48.8% and ADF ranged from 15.7 to 36.8%. Cows fed bromegrass hay produced 1.5 kg/d more FCM and 1.2 kg/d more SCM than those fed alfalfa hay. Concentrate percentage in the diet increased milk yield (28.9, 30.4, and 31.3 kg/d at 40, 50, and 60%, respectively). Methionine hydroxy analog increased milk fat percentage and yield for cows fed diets of 50 and 60% concentrate with alfalfa hay but not for those fed diets of 50 and 60% concentrate with bromegrass hay. Effect of methionine hydroxy analog was not significant for milk fat or yield when diets of 40% concentrate were fed.
(Key words: brome, alfalfa, methionine hydroxy analog)

Abbreviation key: F:C = forage to concentrate ratio, MHA = methionine hydroxy analog.

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INTRODUCTION

Forages represent an important source of nutrients in diets of lactating cows, aid in maintaining milk fat content, and promote normal rumen function. However, information is limited comparing high quality smooth bromegrass and alfalfa hays as sole forages in diets of high producing cows. Homer et al. (7) compared alfalfa and gamagrass hay in diets at a forage: concentrate (F:C) ratio of 50:50 and observed higher milk yields for cows fed alfalfa diets with no effect of forage source on fat content, but this increase in milk production was due primarily to greater DMI. Waldo (23) compared direct-cut orchardgrass and alfalfa silages treated with formic acid or formaldehyde and observed similar milk production and DMI of cows fed the two forages. Donker and Munson (3) found similar BW gains of Holstein heifers fed smooth bromegrass, alfalfa, or a combination of the two hays. Paulson (17) fed diets containing alfalfa, smooth bromegrass, and 50: 50 combination of the two silages to lactating cows at either 75, 65, or 55% of dietary DM. Cows fed alfalfa produced more milk and consumed more DM than those fed bromegrass or a combination of the two silages. Shaver et al. (19) compared prebloom alfalfa with mature bromegrass in diets with a 60:40 F:C ratio and observed an 8.3-kg increase in milk production and a 5.4-kg increase in DMI for cows fed prebloom alfalfa diets.

Several researchers (9, 10, 12, 17, 24) have reported increased milk yields and DMI with increasing dietary concentrate. Lundquist et al. (10) observed an increase in milk production when cows were fed 60 vs. 40% concentrate diets; however, DMI did not differ. Waldo (24) found increase in milk production and DMI from feeding additional concentrate when cows were fed alfalfa or orchardgrass as the source of forage. Macleod et al. (12) found a linear increase in DMI and milk production of first lactation cows when F:C ratios of the diets were 75:25, 55:45, and 35:65. Paulson et al. (17) reported lower milk yields and DMI of cows fed 75% forage compared with 65 or 55% forage diets.

Supplementation of high energy diets for dairy cows with DL-α-hydroxy-α-methyl mercapto butyrate-calcium (MHA) has increased milk fat percentage (2, 6, 8, 10, 11). Lundquist et al. (10) fed MHA in diets that contained either 40 or 60% concentrate. When cows were fed 60% concentrate diets supplemented with MHA, milk fat increased .24 percentage units over controls. Cows did not respond to MHA supplementation with higher milk fat percentage when diet contained 40% concentrate. Most continuous lactating trials evaluating the effect of MHA have used corn silage as part of the forage. The concentration of methionine is less in corn silage than in most grass and legume hays, so the effect of added MHA to diets containing grass or legumes may be different.

Objectives of this study were to compare the effects of high quality bromegrass hay with alfalfa hay in diets containing 40, 50, and 60% concentrate on DM intake, milk yield, and milk composition and to determine the effect of MHA on milk composition and milk yield of cows fed alfalfa or bromegrass hays as the source of forage in diets of various F:C ratios.

MATERIALS AND METHODS

Over a period of 2 yr, 121 Holstein cows (44 primiparous) were assigned to one of 12 dietary treatments in a 2 × 3 × 2 factorial arrangement. Treatment groups were balanced for first or later parity, calving date, and previous mature equivalent production of multiparous cows.

Prepartum diets during the 1st yr for multiparous cows contained corn silage and alfalfa hay. During the 2nd yr, the prepartum diet was alfalfa hay. Ten days prior to expected calving date, cows were fed a grain mix low in Na and Ca to minimize parturient paresis and udder edema. Heifers were fed alfalfa hay prior to calving. Cows received their experimental diets on d 2 after parturition. Experimental diets consisted of a grain mixture at 40, 50, or 60% of dietary DM, and alfalfa (*Medicago sativa* L.) or smooth bromegrass (*Bromus inermis* L.) hays (Table 1) provided the remainder.

The grain portion of the diet consisted of two grain mixes (Table 2) of different CP and mineral contents. The amount of each was varied, depending on the percentage of forage in the diet, to achieve final mixed rations of equivalent N and mineral content. Compositions of total mixed diets are listed in Table 2. Hays were chopped coarsely in a bale chopper prior to mixing. Diets were mixed in a horizontal mixer equipped with load cells and fed as a TMR. Water was added to diets to achieve 60% DM and to decrease separation of ingredients. Two forms of MHA were used during the trial. DL-α-hydroxy-γ-methyl mercapto butyrate-calcium in a dry form was incorporated into the grain mix during the 1st yr. In the 2nd yr, 2-hydroxy-4-(methylthio) butanoic acid (a liquid form) was incorporated with beet pulp to make a premix that was added to the diets.

Cows were fed individually at 0800 and 1300 h in stalls equipped with partitioned mangers and automatic waterers. Amount of feed offered was adjusted to approximately 105% of total intake three times per week. Mangers were cleaned daily, and feed refusals were weighed on Monday, Wednesday, and Friday. Feed ingredients and orts were sampled weekly and analyzed for DM and CP (1). Monthly composites of samples were analyzed for ADF and NDF (5). Cows were milked twice daily at 0450 and 1550 h. Individual milk yields were recorded each milking, and samples were collected biweekly from consecutive p.m. and a.m. milkings. Milk samples were analyzed for fat by the Babcock method, total solids by oven drying at 100°C for 6 h, and CP by macro-Kjeldahl. Four percent FCM was calculated by the formula of Overman and Gaines (16). Solids-corrected milk was calculated by the formula of Tyrrell and Reid (21). Body weights were recorded after calving and once weekly thereafter. Change in BW was the difference between BW just after calving and the average of BW from wk 15 and 16.

Rumen fluid samples were taken by esophageal tube between wk 14 and 16 of lactation at approximately 3 h after the morning feeding. After collection, samples were strained through cheesecloth and analyzed immediately for pH. A 50-ml aliquot then was treated with 1 ml of saturated $HgCl_2$ to stop bacterial action. Samples were frozen until prepared (4) and analyzed for VFA by gas chromatography us-

TABLE 1. Average composition of alfalfa and smooth bromegrass hays.

Item	Alfalfa		Bromegrass	
	Year 1	Year 2	Year 1	Year 2
	(%)			
DM	88.7	87.9	86.1	87.9
CP[1]	19.0	17.8	19.3	19.1
ADF[1]	36.8	36.6	37.9	31.7
NDF[1]	49.2	49.9	66.6	60.6

[1]DM basis.

ing a Model 5880A Hewlett-Packard chromatograph equipped with a 2 m × 3.2 mm i.d. teflon column packed with .3% Carbowax –.1% H_3PO_4 on 60/80 Carbopack (Supelco, Inc., Bellefonte, PA).

Data, collected from d 4 to 116 of lactation, were analyzed by least square analyses with the general linear models procedure (SAS, Cary, NC). Model effects included forage source, percentage of concentrate, MHA, parity (1 vs. > 1), and year plus all possible two-way interactions. Significance was declared at ($P < .10$) unless otherwise noted.

RESULTS AND DISCUSSION

Alfalfa hays (Table 1) used during both years were similar in ADF and NDF, whereas CP tended to be higher during the 1st yr. Bromegrass hay (Table 1) was similar in DM and CP during both years, but ADF and NDF were about 6 percentage units lower during the 2nd yr. In comparisons between bromegrass and alfalfa, NDF averaged 14 percentage units higher for the bromegrass hay. The ADF of bromegrass used during the 2nd yr was about 5 percentage units lower than that of alfalfa.

All diets met NRC (15) recommendations for dietary minerals and vitamins. During both years, the 60% concentrate diets with bromegrass or alfalfa contained less than the 21% ADF recommended (15), Table 2. During yr 2, the diet of 50% grain and 50% bromegrass hay contained 19.6% ADF. Differences in composition of diets reflected the differences in ADF and NDF of the hays. During the 2nd yr, bromegrass hay diets contained less ADF and NDF than the 1st yr.

Older cows consumed more ($P < .05$) DM, CP, ADF, and NDF than 2-yr-old cows. However, because no treatment × parity interactions were found, data for statistical analyses were combined for parity (Table 3).

Dry matter intakes tended to be similar for cows fed bromegrass (20.8 kg/d) and alfalfa (20.3 kg/d) diets. However, year × hay interaction was significant for DMI (Table 4). Dry matter intakes of cows fed bromegrass diets during yr 2 were higher than those of cows fed alfalfa diets during both years and bromegrass

TABLE 2. Ingredient and chemical composition of total mixed rations.

Item	Alfalfa			Bromegrass		
	40%	50%	60%	40%	50%	60%
	(% DM)					
Hay	60.0	50.0	40.0	60.0	50.0	40.0
Concentrate 1[1]	38.2	29.0	38.6	0	0	0
Concentrate 2[2]	0	19.2	19.3	37.3	47.5	57.5
Limestone	0	0	.3	.72	.72	.72
Monosodium phosphate	0	0	0	.22	0	0
Beet pulp or MHA premix[3]	1.8	1.8	1.8	1.8	1.8	1.8
CP	17.5	17.7	17.2	18.4	18.3	18.4
ADF	26.5	22.1	17.7	25.4	21.1	16.7
NDF	38.5	32.1	25.7	47.2	39.2	31.1

[1]Composition (% of DM): 55.45 ground corn, 27.96 ground oats, 3.36 soybean meal, 8.00 dry molasses, 1.40 trace-mineralized salt, 1.12 limestone, 2.24 monoammonium phosphate, .19 magnesium oxide, and .28 vitamin premix.

[2]Composition (% of DM): 49.93 ground corn, 24.41 ground oats, 14.98 soybean meal, 5.27 dry molasses, 1.02 trace-mineralized salt, 1.66 limestone, 2.22 monoammonium phosphate, .22 magnesium oxide, and .28 vitamin premix.

[3]The MHA premix contained 90% beet pulp and 10% methionine hydroxy analog.

TABLE 3. Milk production and composition and feed intake of cows fed alfalfa or bromegrass with three percentages of concentrate without (0) or with (+) .15% methionine hydroxy analog (least squares means).

	Alfalfa hay						Bromegrass hay						
	40%		50%		60%		40%		50%		60%		
Item	0	+	0	+	0	+	0	+	0	+	0	+	SE
Number of cows	10	10	11	11	11	12	9	11	9	9	10	8	
Milk production													
Milk, kg/d	27.7	29.2	30.1	29.4	30.0	32.0	30.6	28.4	30.7	31.5	33.7	28.9	1.55
FCM, kg/d	26.9	27.1	27.1	28.1	26.1	28.6	27.9	26.7	29.2	28.7	31.0	28.0	1.48
SCM, kg/d	27.0	27.1	27.8	28.0	26.9	28.4	27.9	26.7	29.4	28.6	31.2	28.2	1.39
Fat, %	3.80	3.31	3.33	3.69	3.16	3.27	3.42	3.60	3.67	3.39	3.46	3.78	.12
Fat, kg/d	1.05	1.00	1.00	1.09	.94	1.06	1.04	1.02	1.13	1.00	1.16	1.10	.06
Protein, %	3.26	3.08	3.25	3.18	3.27	3.07	3.08	3.17	3.15	3.05	3.08	3.36	.07
Protein, kg/d	.90	.92	.97	.93	.97	.98	.94	.90	.96	.96	1.04	.97	.04
Solids, %	12.69	11.92	12.31	12.42	12.11	11.81	12.10	12.37	12.55	11.96	12.25	12.70	.22
Solids, kg/d	3.51	3.61	3.70	3.65	3.62	3.79	3.69	3.50	3.85	3.79	4.13	3.66	.17
Intake, kg/d													
DM	19.9	20.0	20.5	19.9	20.8	20.8	21.7	20.2	20.2	21.0	20.8	20.6	.70
CP	3.5	3.5	3.7	3.5	3.6	3.6	4.0	3.5	3.7	3.8	3.8	3.8	.13
ADF	5.3	5.4	4.6	4.4	3.7	3.7	5.5	5.1	4.3	4.4	3.5	3.4	.16
NDF	7.6	7.8	6.6	6.4	5.3	5.3	10.3	9.5	8.0	8.3	6.5	6.4	.26

TABLE 4. Milk production, composition, and feed intake of cows fed alfalfa or bromegrass hay diets for 2 yr (least squares means).

	Alfalfa		Bromegrass		Main effect and interactions		
Item	Year 1	Year 2	Year 1	Year 2	Hay	Year	Hay × year
Milk production							
Milk, kg/d	29.7	30.0	29.5	31.8	NS	†	NS
FCM, kg/d	27.0	27.5	27.8	29.5	*	†	NS
SCM, kg/d	27.1	27.7	27.5	29.8	†	*	NS
Fat, %	3.41	3.44	3.61	3.48	*	NS	NS
Fat, kg/d	1.00	1.04	1.06	1.11	*	†	NS
Protein, %	3.19	3.17	3.16	3.13	NS	NS	NS
Protein, kg/d	.94	.95	.92	1.00	NS	*	NS
Solids, %	12.1	12.3	12.3	12.4	NS	†	NS
Solids, kg/d	3.58	3.68	3.60	3.93	NS	*	NS
Feed intake							
DM, kg/d	20.0[a]	20.7[a]	19.5[a]	22.1[b]	NS	*	*
CP, kg/d	3.61[b]	3.50[b]	3.61[b]	4.03[a]	*	†	*
ADF, kg/d	4.41	4.55	4.44	4.31	NS	NS	NS
NDF, kg/d	6.34[b]	6.64[b]	7.97[a]	8.34[a]	*	*	NS

[a,b]Means within rows with different superscripts differ ($P < .05$).

†$P < .10$.

*$P < .05$.

diets during the 1st yr. This interaction probably occurred due to the higher quality of the bromegrass hay fed during the 2nd yr (Table 1). These DMI occurred between hay diets even though NDF intake was 1.2 kg/d higher ($P < .05$) for cows fed bromegrass hay diets compared with those fed alfalfa, whereas ADF intakes were similar (Table 4) between forage sources and years. This observation is contrary to the concept (13, 24) that cows consume greater amounts of legumes than grasses because of lower cell wall contents. However, Donker and Munson (3) showed that DMI of high quality bromegrass and alfalfa hay fed to heifers were equal. These results conflict with those of Shaver (19) and Paulson (17), who showed lower intakes of bromegrass versus alfalfa. Forage quality of the bromegrass hay was not as high in their study (17, 19) as in ours.

Varga and Hoover (22) theorized that variable DMI from comparable amounts of NDF may be due to differences of rate and extent of cell wall digestion. Smith et al. (20) found large differences in rate constants for in vitro disappearance of digestible cell walls (.309 to .04% h^{-1}) and extent of cell wall digestion (27 to 92%). Vegetative bromegrass and prebloom alfalfa had similar NDF rate constants (.183 vs. .191% h^{-1}) but extent was higher for bromegrass (85 vs. 65%). Smith et al. (20) also observed that cell wall digestion rates were highly correlated with hemicellulose:ADF ratio of some grass species including bromegrass (r = .95), but no significant correlation was shown for legumes. This positive correlation indicated that cell walls of grass digested faster than those of alfalfa even though grass contained proportionately greater amounts of hemicellulose.

Proportion of concentrate in the diet affected ADF and NDF intake but did not affect DMI (Table 5), suggesting that NDF was not the factor limiting DMI. Acid detergent fiber and NDF intakes were different ($P < .0001$) among F:C ratios fed. Addition of MHA did not affect DMI. A decrease in DMI occurred when MHA was fed at .8% of concentrate (18).

Ruminal pH and VFA are presented in Table 6. Rumen fluid obtained by esophageal tube may have been contaminated with saliva, and this may have affected rumen pH and total VFA values. Molar percentages of rumen acetate (69 vs. 67 mol/100 mol) were higher ($P < .05$) and propionate (19 vs. 21 mol/100 mol) were lower for cows fed diets containing bromegrass hay compared with those fed diets

TABLE 5. Milk production, milk composition, and feed intake of cows fed three percentages of concentrates (least squares means).

Item	Concentrate (% of DM)		
	40	50	60
Milk production			
Milk, kg/d	28.9[b]	30.4[ab]	31.3[a]
FCM, kg/d	26.9	28.3	28.5
SCM, kg/d	26.9[b]	28.4[ab]	28.8[a]
Fat, %	3.53	3.53	3.42
Fat, kg/d	1.02	1.07	1.07
Protein, %	3.15	3.15	3.19
Protein, kg/d	.91[b]	.96[ab]	.99[a]
Solids, %	12.3	12.3	12.2
Solids, kg/d	3.54[b]	3.73[ab]	3.81[a]
Intake, kg/d			
DM	20.4	20.4	20.7
CP	3.68	3.68	3.69
ADF	5.32[a]	4.41[b]	3.56[c]
NDF	8.80[a]	7.29[b]	5.86[c]

[a,b,c]Means within rows with different superscripts are different ($P < .05$).

containing alfalfa hay. This difference ($P < .05$) in acetate:propionate ratio might be due to the higher percentage of hemicellulose in the bromegrass hay diets. Rumen pH was higher for cows fed diets containing bromegrass hay than alfalfa hay (6.65 vs. 6.54). Percentage of concentrate in the diets did not affect molar percentages of acetate but tended to increase molar percentages of propionate and decrease acetate:propionate ratio as percentage of concentrate in the diet increased.

Older cows produced significantly ($P < .0001$) more milk, FCM, SCM, fat, and protein and had a higher fat test than first lactation cows. Because no treatment by parity interactions were significant for milk yield and composition, further statistical analyses were conducted on combined data for both parities. Combined data for milk yield and milk composition are presented for all treatments in Table 3. Trial year had a significant effect on yields of FCM, SCM, fat, solids, and on per-

TABLE 6. Effects of forage type and concentrate percentage on ruminal pH and VFA (least squares means).

Item	Alfalfa			Bromegrass		
	40%	50%	60%	40%	50%	60%
pH[2]	6.62	6.47	6.56	6.70	6.61	6.60
Total VFA, m*M*	60	82	80	81	74	64
Individual VFA, mol/100 mol						
Acetic (A)[1]	67.5	66.7	66.5	69.2	68.2	68.4
Propionic (P)[1,2]	19.3	20.8	21.6	18.3	19.0	19.8
Butyric[2]	10.0	9.6	9.0	9.8	10.1	9.5
Isobutyric	.71	.75	.75	.79	.75	.76
2-Methylbutyric	.54	.49	.49	.62	.54	.60
Valeric[1]	1.31	1.13	1.14	.79	.92	.54
Isovaleric	.57	.42	.39	.42	.40	.37
A:P ratio[1]	3.63	3.37	3.24	3.84	3.71	3.54

[1]Treatment effect of forage ($P < .05$).

[2]Treatment effect of grain ($P < .10$).

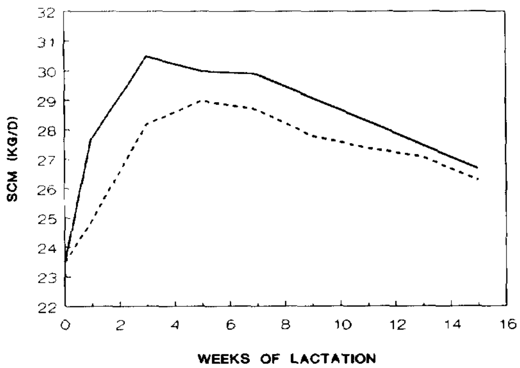

Figure 1. Effect of forage type on SCM. Bromegrass (—); Alfalfa (---).

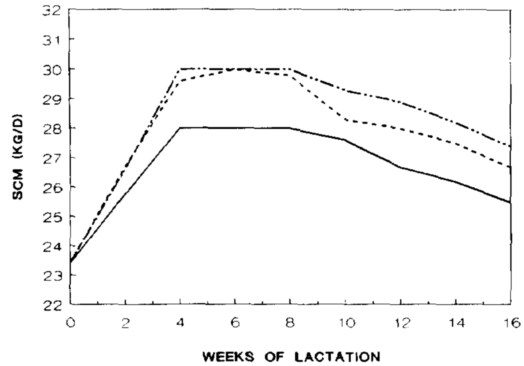

Figure 2. Effect of percentage of concentrate on SCM. 40% concentrate (—); 50% concentrate (---); 60% concentrate (– — –).

centage of solids; however, no significant treatment × year interactions were found.

Bromegrass hay supported higher amounts of FCM ($P < .06$), SCM ($P < .08$), milk fat yields ($P < .02$), and percentage of fat ($P < .02$) (Table 4) than alfalfa hay. The digestibility of fiber in the alfalfa diets may have been depressed compared with bromegrass diets because cows fed bromegrass hay diets had higher ($P < .05$) rumen pH 3 h after feeding than those fed alfalfa diets. Mould et al. (14) partially or totally alleviated fiber digestibility depression of forage-based and barley-based diets compared with total forage diets by maintaining rumen pH at 6.7. When diets were changed from all hay to a high concentrate, rumen cellulolytic microorganisms decreased from 10^6 to 10^4/ml of rumen fluid and rumen pH fell from 6.9 to 6.0. The bromegrass hay may have protected the rumen from a decrease in pH, thus promoting higher cellulolytic activity of the microorganisms. Figure 1 reveals that cows fed bromegrass hay diets produced more milk immediately after parturition and peaked higher than those fed alfalfa diets.

Cows fed 60% concentrate diets produced greater ($P < .05$) amounts of milk, SCM, protein, and total milk solids (Table 5) than those fed diets of 40% concentrate. Milk, SCM, protein, and total milk solids yields for cows fed 50% concentrate diets were intermediate between those of cows fed diets with either 40 or 60% concentrate. This increase in yields of milk and milk components was due to a higher energy density of the 50 and 60% concentrate diets and is consistent with the results of others (9, 10, 12, 17, 24). Least square means by weeks for SCM for cows fed 40, 50, and 60% concentrate diets are presented in Figure 2. The 50 and 60% concentrate diets had similar SCM yields for the first 8 wk of lactation, but the 60% concentrate diet appeared to support higher SCM yields for wk 10 through 16. Cows fed the 40% concentrate diet did not peak as high in SCM as those fed 50 and 60% concen-

TABLE 7. Milk fat percentage as affected by the interactions of concentrate by methionine hydroxy analog (MHA) and concentrate by forage (least squares means).

40%		50%		60%	
0% MHA	.15% MHA	0% MHA	.15% MHA	0% MHA	.15% MHA
3.59^{a}	3.46^{ab}	3.49^{ab}	3.57^{a}	3.31^{b}	3.53^{a}
Alfalfa	Bromegrass	Alfalfa	Bromegrass	Alfalfa	Bromegrass
3.54^{a}	3.51^{a}	3.50^{a}	3.56^{a}	3.21^{b}	3.63^{a}

^{a,b}Means within columns with different superscripts differ ($P < .05$).

trate and remained lower through wk 16.

Milk fat yields were higher ($P < .02$) for cows fed bromegrass hay diets than for those fed alfalfa diets because milk fat percentage was higher and milk yields tended to be higher for cows fed bromegrass diets. Cows fed alfalfa hay and 60% concentrate diets produced milk of significantly lower fat percentage than all other treatments (Table 7). Consequently, interaction between concentrate percentage and forage source was significant ($P < .01$). Milk fat percentage also was affected ($P < .06$) by an interaction between concentrate percentage and MHA (Table 7). Fat contents of milk from cows fed diets containing 50 or 60% concentrate with MHA and 40% concentrate without MHA were higher ($P < .05$) than those of milk from cows fed 60% grain and no MHA. Cows fed 50% concentrate without MHA or 40% concentrate with MHA were intermediate. Previous research has shown MHA to increase effectively the milk fat content in diets higher than 50% concentrate (10). Therefore, contrast analysis of cows fed 50 and 60% concentrate was used to analyze for differences in milk fat yield and percentage. Addition of MHA to alfalfa diets having 50 and 60% concentrate increased milk fat percentage .25 percentage units ($P < .05$) and fat yield .12 kg/d ($P < .07$). Added MHA did not affect milk fat percentage or fat yield of cows fed bromegrass diets. Depression in milk fat percentage may have occurred in the alfalfa and 60% concentrate diets because ADF percentage was 17.7, whereas NRC (15) recommendation is 21%. However bromegrass diets at the same concentrate percentage were only 18.2 and 15.7% ADF for the 2 yr without negative effects on milk fat percentage or fat yield, suggesting that ADF values from these two sources of forage were not identical in effect.

Change in BW was affected by forage source ($P < .06$). Cows fed bromegrass diets lost 24.3 kg, whereas those fed alfalfa diets lost 7.6 kg. Concentrate:forage ratio did not affect BW change.

CONCLUSIONS

Lactating dairy cows fed high quality bromegrass hay can produce as much or more SCM, FCM, and milk fat than those cows fed alfalfa hay as the sole source of dietary forage. Bromegrass hay diets did not depress DMI compared with alfalfa hay diets even though NDF intake was higher in bromegrass hay diets. Milk, SCM, milk protein, and milk solids yields increased with increased concentrate in the diet. Milk fat yield was higher for cows fed supplemental MHA, alfalfa hay, and 50 and 60% concentrate compared with the same diets without MHA. The MHA did not affect fat content or yield of cows fed diets containing 60% forage. Bromegrass hay supported higher molar percentages of ruminal acetate and lower molar percentages of ruminal propionate than alfalfa hay. Possibly because of the high quality of bromegrass hay used in this trial, the use of NDF for prediction of intake would not be satisfactory. Also, low ADF of the 60% concentrate and 40% bromegrass diet did not depress milk fat percentage, as would be expected with alfalfa diets of similar ADF content.

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