Effect of Water Addition on Selective Consumption (Sorting) of Dry Diets by Dairy Cattle

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ABSTRACT

The objective of this study was to determine whether adding water to a dry diet would reduce sorting and improve cow performance. Eighteen multiparous lactating Holstein cows were used in a cross-over design with 21-d periods. Treatments had the same dietary composition and differed only by adding water (WET) or not (DRY). Diets consisted of 10% alfalfa silage, 30% hay (approximately 80% grass and 20% alfalfa), and 60% concentrate [dry matter (DM) basis]. Dietary DM was 80.8% for DRY and 64.4% for WET. Both diets contained 16.9% crude protein and 24.3% neutral detergent fiber. Particle size was determined using the Wisconsin Particle Size Separator on the as-fed diets. The separator has five square-hole screens (Y_1 to Y_5) with diagonal openings of 26.9 mm for Y_1 , 18 mm for Y_2 , 8.98 mm for Y_3 , 5.61 mm for Y_4 , and 1.65 mm for Y_5 , and one pan. Sorting was calculated on a 60°C DM basis (60DM). Predicted intake of Y_i was calculated as the product of 60DM intake (60DMI) and the 60DM fraction of Y_i in the total mixed ration for that screen. For DRY and WET, actual 60DMI by screen expressed as a percentage of predicted intake was 61.4% vs. 75.2% for Y_1 , 83.8% vs. 98.6% for Y_2 , 85.6% vs. 90.8% for Y_3 , 95.2% vs. 96.0% for Y_4 , 100.1% vs. 101.9% for Y_5 , and 105.9% vs. 102.9% for pan, respectively. Adding water did not affect total DM intake (28.3 kg/d) or milk production (41.3 kg/d). Neutral detergent fiber intake was 6.42 kg/d for WET and 6.15 kg/d for DRY. Milk fat percentage tended to be higher (3.41% vs. 3.31%) when cows consumed WET vs. DRY. No differences in ruminal pH, NH_3 , and volatile fatty acids were observed. Cows sorted against long particles in favor of shorter particles on both diets. Adding water to dry diets reduced sorting and tended to increase neutral detergent fiber intake and milk fat percentage.

(**Key words:** sorting, water, long particle)

Abbreviation key: cNDF = NDF concentration in the diet consumed, DRY = basal dry diet without water addition, NDFI = NDF intake, WET = basal dry diet plus 25% water added (DM basis), 60DM = 60°C DM, 60DMI = 60°C DMI.

INTRODUCTION

Any recommendation of minimum dietary fiber or particle size requirements, such as NRC (2001) or Varga et al. (1998), assumed that an animal ingests a diet similar to the diet offered. However, it has been shown recently that lactating dairy cattle ingest a diet that could differ from the diet offered (Leonardi and Armentano, 2003). Dairy cattle sorted against particles retained above screens with square-hole diagonals >18 mm and simultaneously sorted in favor of particles passing through the 1.65-mm screen (Leonardi and Armentano, 2003). In Leonardi and Armentano (2003), the intake of longer particles expressed as a percentage of the predicted intake (sorting) was not affected by quality or particle length of alfalfa hay. However, as the percentage of long particles in the diet increases, equal sorting results in a greater absolute amount of refused long particles. Long particles are usually higher in NDF concentration than the TMR; therefore, the increased long particles refused could reduce total dietary NDF intake as well as the proportion of NDF coming from longer particles. Although other trials have not measured sorting across the entire particle size distribution, indications of sorting can be obtained from reported concentrations of NDF in orts vs. diets. Feeding long-stem vs. chopped alfalfa hay promoted sorting and tended to reduced NDF intake without affecting DMI (Onetti et al., 2004). Similarly, increasing corn silage theoretical length of cut increased orts NDF concentration and reduced NDF intake (Kononoff and Heinrichs, 2003; Kononoff et al., 2003).

One dietary characteristic that affected the extent of sorting within each screen was the amount of alfalfa hay fed (Leonardi and Armentano, 2003). Dry diets with 40% alfalfa hay were sorted more than wetter diets with 20% alfalfa hay and 20% alfalfa silage (Leonardi and Armentano, 2003). In Leonardi and Armentano

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(2003), no milk samples were collected because of short feeding periods. In another experiment (Calberry et al., 2003), where cows were fed a diet that contained (DM basis) either 9.8% alfalfa hay or 4.9% alfalfa hay plus 4.9% alfalfa silage or 9.8% alfalfa silage, feeding either alfalfa hay or alfalfa silage increased the percentage of long particles in orts compared with the diet. Although no statistical analysis has been reported, the magnitude of the increment was greater when cows were fed hay vs. silage (Calberry et al., 2003). Replacing alfalfa hay with alfalfa silage did not affect milk production but numerically increased milk fat percentage from 2.39 to 2.63% (Calberry et al., 2003).

Therefore, the objective of this experiment was to test the hypothesis that water addition to a dry diet would decrease sorting, increase the intake of physically effective NDF and total NDF, and ultimately increase milk fat percentage and yield.

MATERIALS AND METHODS

Animals

Eighteen multiparous lactating Holstein cows were used in a cross-over design with periods of 21 d. Twelve cows were ruminally fistulated. At the beginning of the study, cows averaged 88 ± 29 (mean $\pm$ SD) DIM and produced 41.0 ± 5.3 kg/d of milk. Cows were housed individually in either tie-stalls or stanchions and had free-choice access to water. The Animal Care Committee of the College of Agricultural and Life Sciences of the University of Wisconsin-Madison approved all procedures involving animals.

Diets

The study was conducted from November 2 to December 14, 2000. Treatments had the same dietary composition, and both contained 30% hay (a mixture of approximately 80% grass and 20% alfalfa), 10% alfalfa silage, and 60% concentrate (DM basis; Table 1). Hay was harvested in bales, and prior to conducting the experiment, it was chopped with a tub grinder (model 1000; Olathe Manufacturing, Olathe, KS). Dietary ingredients were mixed for approximately 5 to 10 min in a mixer (Rissler 450, Mohnton, PA) and fed as a TMR for ad libitum intake twice daily at 0800 and 1500 h. Treatments differed only by no addition (**DRY**) or addition of water (**WET**) to the basal diet. Water was sprinkled into the mixer during diet preparation. The amount of water added constituted 25% of the diet (DM basis) and was the amount of water necessary to decrease the dietary DM content from approximately 80% to approximately 65%. This was the maximum amount of water that could be added to the diet without having

Table 1. Diet composition.

Ingredient	Diet ¹
	WET – DRY
	(g/100 g of DM)
Alfalfa silage	10.0
Hay ²	29.8
Corn grain ground	44.8
Soybean meal, 48% CP	13.3
Tallow	0.6
Limestone	0.4
Dicalcium phosphate	0.4
Trace mineral salt ³	0.4
Vitamin mix ⁴	0.25
Magnesium oxide	0.05

¹Diet: DRY = basal dry diet without water added; WET = basal dry diet plus 25% water added (DM basis).

²Hay was a mixture of approximately 80% alfalfa and 20% grass.

³Contained 0.55% Mn, 0.55% Zn, 0.35% Fe, 0.14% Cu, 0.008% I, 0.006% Se, and 0.002% Co.

⁴Contained 3304 IU/g of vitamin A, 1101 IU/g of vitamin D, and 11 IU/g of vitamin E.

water leak through the feeding cart. The amount of feed offered was adjusted daily to obtain approximately 10 to 15% orts (as-fed basis). Actual orts as a percentage of feed offered were 10.9% for WET and 12.9% for DRY (DM basis). Diet chemical composition, which was mathematically calculated from individual feedstuffs, is reported in Table 2.

Sampling and Analysis

Cows were milked twice daily. Milk production was recorded, and milk was sampled at each milking during

Table 2. Chemical composition of forages and diets.

Diet component	Forage		Diet ¹
	Alfalfa silage	Hay	DRY – WET
	(g/100 g of DM)		
NE _L , ² Mcal/kg of DM	—	—	1.61
DM, g/100 g (as fed)	41.3	90.7	80.8 – 64.4
	(g/100 g of DM)		
CP	19.1	14.5	16.9
NDF	41.2	52.3	24.3
NDF from forage	—	—	—
ADF	37.2	38.7	18.2
NFC ³	28.0	20.1	50.3
Fatty acids ⁴	1.4	1.2	2.5
Ash	8.3	9.9	6.6
Calcium ²	—	—	0.65
Phosphorus ²	—	—	0.43

¹Diet: DRY = basal dry diet without water added; WET = basal dry diet plus 25% water added (DM basis).

²Calculated based on NRC (2001) values for individual feedstuffs.

³NFC = nonfibrous carbohydrates; NFC = 100 – (NDF + ether extract + CP + ash), where ether extract was calculated as fatty acids plus one (NRC, 2001).

⁴Fatty acids represented the sum of C_{12:0} to C_{18:3}.

Table 3. Forage and diet particle size distribution and geometric mean particle length (GMPL). Values are means $\pm$ standard deviations.

Diagonal size of screen openings								
Item	no.	26.9 mm	18 mm	8.98 mm	5.61 mm	1.65 mm	Pan	GMPL ¹
————— (% retained on each screen; DM basis) ————— (mm)								
Forage								
Alfalfa silage	4	4.2 ± 0.6	12.1 ± 1.3	41.8 ± 0.7	15.8 ± 0.8	19.0 ± 1.4	7.1 ± 1.2	8.2
Hay	4	8.5 ± 1.1	7.2 ± 0.8	12.0 ± 1.0	11.2 ± 0.5	15.3 ± 0.9	45.8 ± 1.0	3.2
Diet ²								
DRY	4	2.6 ± 0.4	3.8 ± 0.4	9.1 ± 1.0	7.1 ± 0.4	30.2 ± 0.3	47.2 ± 2.0	2.3
WET	4	1.9 ± 0.4	3.3 ± 0.4	8.4 ± 0.7	7.2 ± 0.2	35.6 ± 0.7	43.5 ± 0.9	2.4

¹Determined by dry-sieving using University of Wisconsin forage particle size separator in accordance with ASAE standard S424 (1998).

²Diet: DRY = basal dry diet without water added; WET = basal dry diet plus 25% water added (DM basis).

the last 5 d of each period. Milk samples were analyzed for protein, fat, lactose, and SNF by infrared analysis (AgSource Milk Analysis Laboratory, Menomonie, WI) with a Fossmatic-605 (Foss Electric, Hillerød, Denmark) according to AOAC (1990).

Diets were adjusted weekly to account for forage DM fluctuation. Feed samples were collected during the last 2 wk of each experimental period, dried at 60°C for 48 h, ground to pass through a 1-mm screen (Wiley mill, Arthur H. Thomas, Philadelphia, PA), and analyzed for DM, OM, CP, NDF, ADF, and fatty acids. Orts were sampled during the last 5 d of each period and composited by animal in proportion to the wet weight of Orts on each specific day. The composite Ort samples were dried at 60°C for 48 h and analyzed for DM and NDF. Samples of Orts and diets were collected for particle size distribution determination during the last 2 d of each period. Particle size distribution of forages, diets, and Orts was determined by dry-sieving using the Wisconsin Particle Size Separator in accordance with the ASAE standard S424.1 protocol (ANSI, 1998) and reported on a 60°C DM basis (**60DM**). Geometric mean particle length was calculated assuming a mean length of 48 mm for the material retained on the top screen of the separator. The separator has five square-hole screens (Y₁ to Y₅) with diagonal openings of 26.9 mm for Y₁, 18 mm for Y₂, 8.98 mm for Y₃, 5.61 mm for Y₄, and 1.65 mm for Y₅, and one pan. Diets and Orts samples from each screen were collected and dried at 60°C for 48 h to calculate intake and sorting of each screen on a 60DM basis. Forages and dietary particle size distribution and geometric mean particle length are reported on a 60DM basis (Table 3).

The analytical DM was determined by oven drying at 100°C for 24 h, and OM was determined by ashing at 550°C for 12 h. Crude protein content was determined by micro-Kjeldahl analysis (AOAC, 1990). Neutral detergent fiber was determined according to Van

Soest et al. (1991) adapted for Ankom²⁰⁰ Fiber Analyzer (Ankom Technology, Fairport, NY) using α -amylase sodium sulfite and corrected for ash concentration. Acid detergent fiber was determined using the method described by Goering and Van Soest (1970), adapted for Ankom²⁰⁰ Fiber Analyzer (Ankom Technology). Fatty acids were determined by following the procedure described by Sukhija and Palmquist (1988) and represented the sum of C₁₂ to C_{18:3}. The nonfibrous carbohydrate component was calculated as 100 – (NDF + ether extract + CP + ash), where ether extract was calculated as fatty acids plus one (NRC, 2001). Reported nonfibrous carbohydrate values are not corrected for NDFCP or NPN.

On d 20 of each period, rumen fluid from 12 cows was collected every 2 h for a 24-h period, starting immediately before feeding. Samples were taken from 4 different locations in the rumen with a metal filter probe. Rumen pH was determined immediately after the sample was collected (Twin pH-meter model B-123; Spectrum Technologies Inc., Plainfield, IL). One milliliter of rumen fluid was mixed with 20 μ L of 50% TCA and frozen until analysis for NH₃N (Chaney and Marbach, 1962); 1 mL of rumen fluid was acidified with 20 μ L of 50% H₂SO₄ and was frozen until analysis for VFA as described by Bal et al. (2000).

Calculations and Statistical Analysis

Sorting is reported on as-fed basis and on a DM basis. Sorting on the as-fed basis was calculated as described by Leonardi and Armentano (2003) and on the DM basis was calculated as described subsequently. Sorting was calculated as the actual 60°C DMI (**60DMI**) of each screen (Y₁ to pan) expressed as a percentage of the predicted 60DMI. Predicted intake of Y_i equals the product of 60DMI and the 60DM fraction of Y_i in the TMR for that screen. Values equal to 100% indicate no

Figure 1. Cow variability for sorting by screen (60°C DM basis). Sorting was measured on d 20 and 21 of each experimental period. Cows were fed a basal dry diet without water added (DRY). The separator has 5 square-hole screens (Y₁ to Y₅) with diagonal openings of 26.9 mm for Y₁ (◇), 18.0 mm for Y₂ (■), 8.98 mm for Y₃ (▲), 5.61 mm for Y₄ (●), 1.65 mm for Y₅ (□), and pan (○). 60DMI = 60°C DMI.

Figure 2. Cow variability for sorting by screen (60°C DM basis). Sorting was measured on d 20 and 21 of each experimental period. Cows were fed a basal dry diet plus 25% (DM basis) water added (WET). The separator has 5 square-hole screens (Y₁ to Y₅) with diagonal openings of 26.9 mm for Y₁ (◇), 18.0 mm for Y₂ (■), 8.98 mm for Y₃ (▲), 5.61 mm for Y₄ (●), 1.65 mm for Y₅ (□), and pan (○). 60DMI = 60°C DMI.

sorting, <100% show selective refusals, and >100% indicate preferential consumption.

Data were analyzed using the mixed procedure of SAS (SAS, 1998). Daily DMI, milk production, milk composition, and sorting ($n = 36$) were analyzed including the effects of sequence, period, and treatment in the final model. Cow was designated random. Ruminal pH ($n = 288$), VFA ($n = 287$), and NH₃ ($n = 288$) were analyzed by time as repeated measurements, utilizing a first-order auto-regressive covariance structure, which provided the model with the best fit according to the Schwarz Bayesian criterion. The final model included sequence, period, time, treatment, time $\times$ treatment, time $\times$ period, and time $\times$ sequence. Terms specified for the random statement were cow and treatment $\times$ period $\times$ sequence $\times$ cow. Values reported are least squares means. Significance was declared at $P \leq 0.05$, and a trend was reported if $0.05 < P \leq 0.15$.

RESULTS AND DISCUSSION

Particle size distribution of the 2 diets was similar, except for the smaller particles (Table 3). Numerically, more material was retained on Y₅ for WET vs. DRY and vice versa on the pan. This was probably the result of smallest particles attaching to the particles retained on Y₅ when water was added to the diet.

Sorting and Intakes

Overall, cows sorted against longer particles in favor of shorter particles (Figures 1 and 2). When fed DRY, 50% of the cows ate <60% of their predicted 60DMI of Y₁ (Figure 1). Instead, when fed WET, 28% of the cows

ate <60% of their predicted 60DMI of Y₁ (Figure 2). Feeding diets containing 40% alfalfa hay (DM basis) and that had a dietary DM concentration of 89.9% resulted in similar cow variability as feeding DRY (Leonardi and Armentano, 2003). Specifically, 54% of the cows fed 40% alfalfa hay ate <60% of their predicted Y₁ intake (Leonardi and Armentano, 2003).

Water addition decreased sorting against the longer particles and also decreased preferential consumption of the shorter particles (Figure 3). Water addition in-

Figure 3. Effect of dietary DM content on sorting [$100 \times (Y_1 \text{ 60DMI}/Y_1 \text{ predicted 60DMI})$] activity (60DMI = 60°C DMI basis). Diets consisted of DRY (basal dry diet without water added) and WET (basal dry diet plus 25% water added) (DM basis). Screens are labeled from left (long material) to right (fine material) as Y₁ (white), Y₂ (black), Y₃ (horizontal lines), Y₄ (vertical lines), Y₅ (diagonal lines up), and pan (diagonal lines down). Comparison between DRY vs. WET are noted at *** $P < 0.0001$, ** $P < 0.01$, * $P < 0.05$, and † $P < 0.15$. Data are least squares means $\pm$ SEM.

Figure 4. Effect of dietary DM content on sorting $[(100 \times (Y_1 \text{ intake} / Y_1 \text{ predicted intake}))]$ activity (as-fed basis). Diets consisted of DRY (basal dry diet without water added) and WET (basal dry diet plus 25% water added) (DM basis). Screens are labeled from left (long material) to right (fine material) as Y_1 (white), Y_2 (black), Y_3 (horizontal lines), Y_4 (vertical lines), Y_5 (diagonal lines up), and pan (diagonal lines down). Comparison between DRY vs. WET are noted as *** $P < 0.0001$, ** $P < 0.01$, * $P < 0.05$, and † $P < 0.15$. Data are least squares means $\pm$ SEM.

creased 60DMI of Y_1 particles expressed as a percentage of predicted 60DMI from 61.4 to 75.2% ($P = 0.05$), increased 60DMI of Y_2 from 83.8 to 98.6% ($P < 0.0001$), and increased 60DMI of Y_3 from 85.6 to 90.8% ($P = 0.05$). It also decreased the 60DMI of the pan expressed as a percentage of predicted 60DMI from 105.9 to 102.9% ($P = 0.01$). Sorting values on an as-fed basis were similar to those on a DM basis (Figures 3 and 4). Water addition reduced sorting of Y_2 , Y_3 , and pan when expressed both on a DM and an as-fed basis.

In a previously conducted experiment, replacing 50% of alfalfa hay with alfalfa silage decreased dietary DM concentration from 89.9 to 69.3%. Simultaneously, replacing alfalfa hay with silage decreased sorting to a similar extent as the water addition in the present experiment. For example, replacing alfalfa hay with silage increased the intake of Y_1 particles as a percentage of predicted intake from approximately 60 to 87% (Leonardi and Armentano, 2003). However, in Leonardi and Armentano (2003), it was not possible to attribute decreased sorting solely to increased dietary moisture concentration. Similar results have also been obtained in another experiment where alfalfa silage replaced alfalfa hay, and the Penn State Particle Separator was used to determine particle size distribution (Calberry et al., 2003). Although no statistical analysis was conducted because orts were pooled by diet, replacing alfalfa hay with silage numerically reduced the percentage of longer particles in the orts from approximately 28 to 23% (Calberry et al., 2003). Based on the results

Table 4. Effect of dietary DM content on intake, diet, and ort chemical composition.

Item	Diet ¹		SEM	Statistical contrast
	DRY	WET		$P =$
DMI, kg/d	28.3	28.3	0.9	0.88
NDFI, ² kg/d	6.15	6.42	0.24	0.11
cNDF, ³ %	21.7	22.6	0.2	0.002
DM of orts, %	69.7	57.2	1.2	0.0001
NDF of orts, %	41.7	38.1	1.2	0.007

¹Diet: DRY = basal dry diet without water added, WET = basal dry diet plus 25% water added (DM basis).

²NDFI = NDF intake.

³cNDF = NDF concentration of diet consumed = (NDFI/DMI) $\times$ 100.

reported in our current study, it seems reasonable to attribute the decreased sorting with silages to a decreased dietary DM concentration.

Feeding DRY vs. WET did not affect DMI (Table 4). Although nonsignificant ($P = 0.11$), the numerical decrease in NDF intake (NDFI) when feeding WET vs. DRY is in agreement with the reduced sorting. The numerically lower NDFI was due to a higher NDF concentration in the orts of DRY compared with WET. Orts NDF concentration was 41.7% for DRY and 38.1% for WET ($P = 0.007$; Table 4). When NDFI was expressed as a percentage of DMI, the NDF concentration in the diet consumed (cNDF) was 21.7% for DRY and 22.6% for WET ($P = 0.002$; Table 4). The NDF concentration of diets offered was 24.3%, which was 1.7 percentage units higher than cNDF for WET. Therefore, although water addition reduced sorting, it did not totally reverse the negative effect that feeding an alfalfa hay-based diet had on sorting. To the best of our knowledge, sorting and NDFI were not concurrently measured in experiments where dietary treatments consisted of alfalfa silage replacing hay. However, in another experiment, feeding long stem in place of chopped alfalfa hay promoted sorting and tended to decrease NDFI without affecting DMI (Onetti et al., 2004). Similarly, increasing corn silage particle length increased NDF concentration of orts and decreased NDFI, but also decreased DMI (Kononoff and Heinrichs, 2003; Kononoff et al., 2003). However, when the cNDF was calculated, increasing corn silage particle length decreased the cNDF from 30.5 to 29.0% (Kononoff and Heinrichs, 2003). Therefore, overall sorting affected the particle size distribution and also tended to affect the chemical composition of the diet ingested.

Rumen Measurements

Despite the reduced sorting, there were no significant differences in rumen pH, NH_3 , total VFA, and M per-

Table 5. Effect of dietary DM content on ruminal pH, NH₃, and VFA.

Item	Diet ¹		SEM	Statistical contrast
	DRY	WET		P=
pH	6.38	6.39	0.03	0.72
NH ₃ , mg/dL	9.61	9.29	0.48	0.63
VFA, mM	143.6	142.2	2.9	0.74
	— (mol/100 mol) —			
Acetate (A)	56.1	56.1	0.7	0.93
Propionate (P)	28.9	29.1	0.7	0.85
Butyrate	10.8	10.6	0.3	0.56
A:P	1.98	1.98	0.07	0.98

¹Diet: DRY = basal dry diet without water added; WET = basal dry diet plus 25% water added (DM basis).

centage of individual VFA between diets (Table 5). Furthermore, no significant treatment $\times$ time interaction was observed. The average pH was 6.39, indicating that cows were not acidotic. Nadir ruminal pH was reached 12 h after the morning feeding and was 6.06 for both diets. Various studies reported no correlation between NDFI and average ruminal pH within study (Krause et al., 2002; Beauchemin et al., 2003). Allen (1997) also reported no relationship between dietary NDF concentration and mean ruminal pH across numerous studies.

Milk Production and Milk Composition

Milk production and milk composition, except milk fat percentage, were similar between diets (Table 6). Milk fat percentage was 3.31% for DRY and was 3.41% for WET ($P = 0.09$). There was no difference in milk yield, and the increased milk fat percentage did not result in increased milk fat yield ($P = 0.23$). The trend in increased milk fat percentage caused by water addition

Table 6. Effect of dietary DM content on milk yield and milk composition.

Item	Diet ¹		SEM	Statistical contrast
	DRY	WET		P=
Milk yield, kg/d	41.4	41.2	1.3	0.70
Milk composition, %				
True protein	3.17	3.16	0.06	0.59
Fat	3.31	3.41	0.10	0.09
Lactose	4.80	4.80	0.04	0.96
SNF	8.98	8.99	0.07	0.75
Milk component yield, g/d				
True protein	1303	1294	30	0.58
Fat	1364	1396	49	0.23
Lactose	1989	1978	66	0.69
SNF	3707	3694	105	0.78

¹Diet: DRY = basal dry diet without water added; WET = basal dry diet plus 25% water added (DM basis).

was probably the result of decreased sorting and the trend in increased NDFI. It is not clear how sorting and NDFI can affect milk fat. Various researchers found no correlation within experiments between milk fat percentage and NDFI (Yang et al., 2001; Krause et al., 2002; Beauchemin et al., 2003). It has recently been shown that a decrease in rumen pH can promote the synthesis of *trans* fatty acids, which inhibited milk fat synthesis (Griinari et al., 1998). Milk fatty acid profile was not determined in the present experiment, and also there were no differences between diets in any of the rumen parameters measured including pH. In Onetti et al. (2004), feeding long stem vs. chopped hay promoted sorting, tended to decrease NDFI, and decreased milk fat percentage and yield. Concurrently, milk concentration of *trans*-10 C18:1 increased, although average rumen pH was actually higher when feeding long stem vs. chopped hay. These results suggest that factors other than average ruminal pH may affect milk fat percentage. At the present time, no studies correlated sorting and milk fat percentage; however, further studies in which sorting is measured might support or refute the results observed in the present experiment.

CONCLUSIONS

Feeding dry diets (80.8% DM) containing 30% hay caused cows to avoid consuming long particles. The inclusion of water in a dry diet partially reduced sorting; however, sorting of longer particles varied across animals even when water was added. Water addition to dry diets appears to be a cost effective management practice that could be implemented on dairy farms to reduce sorting.

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