Effect of dietary dry matter concentration on the sorting behavior of lactating dairy cows fed a total mixed ration

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ABSTRACT

The objective of this study was to determine whether addition of water to a high-moisture total mixed ration reduces feed sorting by dairy cattle. Twelve lactating Holstein cows, individually fed once per day, were tested on 2 diets in a crossover design with 21-d periods. Diets had the same dietary composition and differed only in dry matter content, which was reduced by the addition of water. Treatment diets were 1) dry (57.6% DM) and 2) wet (47.9% DM). Dry matter intake (DMI) and milk production were monitored for each animal for the last 7 d of both treatment periods. For the final 3 d of each period, milk samples were taken for composition analysis and fresh feed andorts were sampled for particle size analysis. The particle size separator had 3 screens (19, 8, and 1.18 mm) and a bottom pan, resulting in 4 fractions (long, medium, short, fine). Sorting was calculated as the actual intake of each particle size fraction expressed as a percentage of the predicted intake of that fraction. Contrary to the hypothesis, cows sorted the wet diet more extensively than the dry diet. Sorting of the dry diet was limited to a tendency to refuse short particles, whereas the wet diet was sorted against long particles and for short and fine particles. Water addition reduced DMI, neutral detergent fiber intake, and starch intake of cows on the wet diet. Increased sorting on the wet diet resulted in a tendency for decreased concentration of dietary neutral detergent fiber consumed and also resulted in increased starch concentration of the diet consumed. Milk production and components were unaffected by treatment. Our results suggest that water addition to high-moisture total mixed rations, containing primarily haylage and silage forage sources, may not be an effective method to reduce sorting. Furthermore, water addition may negatively affect DMI and encourage sorting, resulting in the consumption of a ration with different nutrient composition than intended.

Key words: sorting, dry matter content, dairy cow

INTRODUCTION

Total mixed rations are designed as a homogeneous mixture to help minimize the selective consumption of individual feed components by dairy cattle (Coppock et al., 1981). Despite providing feed as a TMR, researchers have shown that extensive diet selection (sorting) of a TMR occurs. In previous research, DeVries et al. (2005) found that the NDF content of the TMR in the feed bunk increased throughout the day, indicating cows were selecting against greater fiber components of the diet. Similarly, other researchers have shown that most cows tend to select for smaller concentrate particles instead of long forage particles (Leonardi and Armen-tano, 2003). In such cases, the diet actually consumed by cows is greater in fermentable carbohydrates than intended and lesser in effective fiber, thereby increasing the risk of subacute ruminal acidosis (DeVries et al., 2008).

One proposed method of reducing feed sorting is the addition of water to dry TMR (Shaver, 2002). It is commonly believed that addition of water to dry TMR will bind particles together and make it harder for dairy cattle to sort out fine particles. This hypothesis was tested in an experiment by Leonardi et al. (2005), who showed a reduction in the extent of feed sorting against long particles and for short particles when water was added to a dry TMR (80% DM). There was also a trend for cows to increase NDF intake with the wetter ration. The greater intake of long, fibrous particles on the wetter ration likely contributed to the trend for greater milk fat percentage (3.41 vs. 3.31%; Leonardi et al., 2005). These authors concluded that the addition of water to dry dairy TMR is a cost-effective management practice that dairy producers may implement to reduce sorting. A major caveat in interpretation and implementation of the results of this study is the fact that the ration tested was much drier than that typically utilized for high-production dairy herds (40 to 60% DM; Eastridge, 2006). Even the “wet” ration (64% DM) in the aforementioned study would be considered somewhat dry compared with those TMR that utilize haylage and silage as the primary forage sources. The objective, therefore, of this study was to further

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examine the effects of dietary DM concentration on the feed sorting behavior of lactating dairy cows fed a high-moisture TMR. The hypothesis for the study was that the addition of water to a high-moisture TMR will decrease feed sorting, and thus decrease the refusal of NDF, and will ultimately increase milk fat percentage and yield.

MATERIALS AND METHODS

Animals and Housing

Twelve lactating Holstein cows, 6 primiparous and 6 multiparous (parity = 2.8 ± 1.2 ; mean $\pm$ SD), were used in the study. Animals were 139.3 ± 53.3 DIM at the beginning of the data collection period. Cows were housed together in a tie-stall barn located at the University of Guelph, Kemptville Campus Dairy Education and Research Centre (Kemptville, ON, Canada). Cows were managed according to the guidelines set by the Canadian Council on Animal Care (1993).

Each cow was individually housed in a tie stall with ad libitum access to water (via an individual water bowl) and feed (via a feed bunk containing dividers separating adjacent cows' feed). Cows were milked in their stalls twice daily at 0500 and 1600 h. Cows were fed a TMR once daily at 1000 h. Orts from each feeding were removed from the feed bunk before the subsequent feed delivery. Cows were given a 2-h exercise period (0800 to 1000 h) each day in an outside dry lot pen. The experiment was conducted between May 17 and June 27. The average environmental temperature during the data collection periods was $17.9 \pm 2.5^\circ\text{C}$.

Experimental Design and Diets

The number of animals required per treatment was determined through power analysis (Morris, 1999) for the primary response variables, including DMI, feed sorting, and milk production and composition. Estimates of variation for these variables were based on previously reported values (Leonardi et al., 2005; DeVries et al., 2007; Bhandari et al., 2008). Cows were divided into 2 groups of 6, which were balanced according to DIM, milk production, and average parity (1.9 ± 1.2). These groups were created by blocking cows into groups of 2 cows (similar in parity, DIM, and milk production), and then randomly assigning the cows in these blocks to 1 of the 2 experimental groups.

Cows were then exposed to 2 treatments (Table 1) in a crossover design with 21-d periods. The treatments were: 1) control diet (designated dry), and 2) control diet with water (designated wet). The control diet was formulated to meet nutrient requirements of high-

producing lactating dairy cows (NRC, 2001). Dietary ingredients were mixed for approximately 10 min in a TMR mixer wagon (Reel-Auggie model 3250, Kuhn Knight, Inc., Brodhead, WI). After mixing, the ration was transferred to a feed cart (WIC MDR-55, Ideal Machinery Inc., Wickham, QC, Canada) from which cows were fed. No mixing of the ration occurred while the ration was being fed. For the wet diet, water was added into the mixer during diet preparation. The amount of water added constituted 20% of the diet (DM basis) and was the amount of water necessary to decrease the dietary DM content from approximately 60% to approximately 50%. The amount of feed offered to each cow was adjusted daily to ensure approximately 15% Orts. Cows were kept on their respective treatments for 21 d and then switched to the other treatment and fed for an additional 21 d.

Feed Sampling and Analysis

For determination of DM and nutrient content, representative samples of treatment TMR and individual Orts of each cow were taken during the last 7 d of each treatment period. Duplicate samples of treatment TMR and individual Orts of each cow were taken for particle size separation during the last 3 d of each treatment period. Additionally, on the third last day of each treatment period, duplicate samples of the dietary components were taken to estimate particle size analysis and chemical analysis. All samples were immediately frozen at -20°C until they were further analyzed.

Samples for particle size separation were separated using the 3-screen (19, 8, and 1.18 mm) Penn State Particle Separator (**PSPS**; Kononoff et al., 2003). This separated the particles into 4 fractions: long (>19 mm), medium (<19 , >8 mm), short (<8 , >1.18 mm) and fine (<1.18 mm) particles. After separation, the DM of each separated fraction was determined by oven drying at 55°C for 48 h. The physical effectiveness factor (**pef**) was determined as the DM proportion of particles retained by the top 2 sieves of the PSPS (Yang and Beauchemin, 2006). The physically effective NDF (**peNDF**) was calculated by multiplying the NDF content of the feed by the pef.

Samples taken for DM and chemical analysis were oven-dried at 55°C for 48 h and then ground to pass through a 1-mm screen (Brinkmann Mill, Brinkmann Instruments Co., Westbury, NY). These samples, plus the dried TMR particle fractions, were sent to Cumberland Valley Analytical Services Inc. (Maugansville, MD) for analysis of DM (135°C ; AOAC, 2000; method 930.15), ash (535°C ; AOAC, 2000; method 942.05), ADF (AOAC, 2000; method 973.18), NDF with heat-stable α -amylase and sodium sulfite (Van Soest et al., 1991),

and CP ($N \times 6.25$; AOAC, 2000; method 990.03; Leco FP-528 Nitrogen Analyzer, Leco, St. Joseph, MI).

Milk Production and Components

Daily milk production for each cow was monitored for the last 7 d of each experimental period. Milk samples were taken from each animal at each milking for the last 3 d of each treatment period. These samples were sent to the DHI testing laboratory (Ontario Dairy Herd Improvement Corp., Guelph, Ontario, Canada) for analysis. Milk samples were analyzed for milk protein and fat percentage using a near-infrared analyzer (Foss System 4000, Foss Electric, Hillerød, Denmark). Milk fat and protein yield (kg/d) were calculated, for the last 3 d of each treatment period, based on the product of the milk production yield and milk composition at each milking on those days.

Calculations and Statistical Analysis

Sorting activity for each fraction of the PSPS was calculated as the actual intake of each fraction expressed as a percentage of the predicted intake of that fraction (Leonardi and Armentano, 2003). The predicted intake of an individual fraction was calculated as the product of the DMI of the total diet multiplied by the DM percentage of that fraction in the fed TMR. Values equal to 100% indicate no sorting, <100% indicate selective refusals (sorting against), and >100% indicate preferential consumption (sorting for).

Data for the particle size distribution, pef, and peNDF of the diets, DM content of the TMR and orts, as well as the daily intakes, sorting activity, milk yield, and milk composition were summarized for each cow by treatment period. To test whether sorting of the experimental diets occurred, sorting activity for each fraction of the PSPS was summarized by treatment and tested for a difference from 100 using *t*-tests. All data were then analyzed using the Mixed procedure of SAS (SAS Institute, 2003). The final model included the fixed effects of period, order, and treatment, the random effect of cow within order, and the residual error. Interactions of the fixed effects were tested in the initial model and were not significant; therefore, they were dropped from the final analysis. All values reported are least squares means. Significance was declared at $P \leq 0.05$, and trends reported if $0.05 < P \leq 0.10$.

RESULTS

Nutrient composition and particle size distribution of treatment diets are reported in Table 1 and Table 2, respectively. The addition of water to the dry diet reduced

Table 1. Ingredient and chemical composition of the treatment diets

Composition	Diet ¹	
	Dry	Wet
Ingredient, %DM		
Corn silage ²		27.04
Alfalfa haylage ³		27.04
High moisture corn		28.10
Concentrate pellet ⁴		17.83
Chemical composition ⁵		
DM, %	57.6 ± 2.6	47.9 ± 4.9
OM, % of DM	92.1 ± 0.6	
CP, % of DM	17.4 ± 0.5	
ADF, % of DM	19.1 ± 0.8	
NDF, % of DM	29.6 ± 0.9	
NFC, % of DM	43.3 ± 1.2	
Starch, % of DM	28.5 ± 1.0	

¹Dry = control diet without water added; wet = control diet plus 20% water added (DM basis).

²Corn silage had a DM of $46.9 \pm 4.1\%$ and chemical composition (DM basis) of $7.6 \pm 0.1\%$ CP, $20.2 \pm 0.3\%$ ADF, and $35.0 \pm 1.1\%$ NDF. Particle size distribution of corn silage (DM basis) was $4.5 \pm 0.8\%$ long, $70.5 \pm 6.1\%$ medium, $22.2 \pm 3.1\%$ short, and $2.8 \pm 2.2\%$ fine particles. Particle size was determined by a Penn State Particle Separator, which has a 19-mm screen (long), 8-mm screen (medium), 1.18-mm screen (short), and a pan (fine).

³Alfalfa haylage had a DM of $53.6 \pm 2.3\%$ and chemical composition (DM basis) of $20.8 \pm 0.7\%$ CP, $36.3 \pm 2.2\%$ ADF, and $44.9 \pm 1.6\%$ NDF. Particle size distribution of alfalfa haylage (DM basis) was $31.0 \pm 4.2\%$ long, $36.9 \pm 2.0\%$ medium, $24.2 \pm 0.3\%$ short, and $7.8 \pm 2.5\%$ fine particles.

⁴Supplied by New-Life Mills Ltd. (Inkerman, ON, Canada), containing (on as-is basis): 31.1% soybean meal, 24.8% Tri-Pro Gold (Tri-County Protein Corp., Winchester, ON, Canada), 16.9% corn gluten meal, 11.3% canola meal, 5.1% trace mineral/vitamin premix, 4.4% sodium bicarbonate, 4.4% ground limestone, 1.9% cobaltized-iodized salt.

⁵Values were obtained from chemical analysis of TMR samples. OM = $100 - \%$ ash. NFC = $100 - (\%CP + \%NDF + \%fat + \%ash)$.

the DM by approximately 10% to produce the wet diet. The particle size distribution of the TMR was affected by the addition of water, with a decreased amount of DM retained in the pan (<1.18 mm). There was no difference in pef and peNDF between diets. The NDF and starch content of the different particle fractions were not different between diets. The NDF content decreased with particle size in both diets, whereas starch content was less for long particles, and greater for the 3 smaller particle fractions. The DM percentage of the different particle fractions of the offered and refused TMR can be seen in Table 3. The DM percentage was less for the wet diet, whereas DM percentage generally increased with decreased particle size across treatments.

Cows sorted against long particles (>19.0 mm) when fed the wet diet, but did not sort against these on the dry diet (Table 4), resulting in a tendency for a difference between treatments. There was no overall sorting for or against medium particles (<19.0, >8.0 mm) on either treatment diet. Cows tended to sort against short particles (<8.0, >1.18 mm) when fed the dry diet, but

Table 2. Particle size distribution,¹ NDF, and starch content of the particle fractions, and effective fiber content of the treatment diets

Item	Diet ²		SE	P-value
	Dry	Wet		
% DM retained on screen				
Long	8.8	9.1	0.3	0.7
Medium	46.6	49.3	1.2	0.16
Short	33.5	34.5	0.8	0.4
Fine	11.0	7.2	0.8	0.007
NDF, % of screen DM				
Long	55.3	49.8	0.6	0.16
Medium	32.2	32.2	0.1	0.99
Short	22.4	22.1	0.4	0.7
Fine	22.1	16.8	1.6	0.3
Starch, % of screen DM				
Long	6.4	8.2	0.4	0.17
Medium	27.9	30.0	0.8	0.3
Short	31.8	31.8	0.3	0.9
Fine	32.0	27.6	1.2	0.2
pef ³	55.5	58.3	1.3	0.16
peNDF, ⁴ % of DM	16.4	17.3	0.4	0.16

¹Particle size was determined by a Penn State Particle Separator, which has a 19-mm screen (long), 8-mm screen (medium), 1.18-mm screen (short), and a pan (fine).

²Dry = basal dry diet without water added; wet = basal dry diet plus 20% water added (DM basis).

³pef = physical effectiveness factor determined as the proportion of particles retained by top 2 sieves of the Penn State Particle Separator (Yang and Beauchemin, 2006).

⁴peNDF = measured as the NDF content of the TMR (DM basis) multiplied by the pef.

sorted for these particles on the wet diet, resulting in a difference between treatments. Cows also sorted for fine particles (<1.18 mm) when fed the wet diet, but did not sort against these on the dry diet.

The difference in intakes between diets is reported in Table 5. Dry matter content of the feed affected DMI, which was less when cows were on the wet diet compared with the dry diet. However, the cows tended to consume more wet matter feed on the wet diet than

when they were on the dry diet, which corresponded to a significantly greater intake of water in feed when fed the wet diet. Neutral detergent fiber intake was less when cows were on the wet diet, whereas the NDF concentration of diet consumed also tended to be less on this diet. Starch intake was also less when cows were on the wet diet; however, the starch concentration of the diet consumed was greater on that diet. There was no difference in percentage of feed refused of the different diets. Dietary DM had no effect on milk yield or composition (Table 6).

DISCUSSION

The 2 treatment diets in this study had the same composition but differed in DM content by 10% because of the addition of water to the TMR. The addition of water also changed the particle size distribution, reducing the amount of DM retained in the pan. This effect of water addition on feed has been previously seen with feeds of various compositions (Leonardi et al., 2005; Hosseinkhani et al., 2007) and was attributed to water causing the fine particles to stick to larger particles.

Contrary to our hypothesis, sorting was not reduced by the addition of water to the TMR; rather, the addition of water to the dry diet increased sorting. This result is in contrast to the findings of Leonardi et al. (2005) who found that adding water to a TMR reduced the degree of sorting. Surprisingly, in the present study, very little sorting of the dry diet actually occurred, with the exception of a tendency to sort against short particles. This amount and type of sorting is unusual, given that cows, both tie-stall and free-stall housed, typically have been shown to sort their TMR against long particles and for shorter particles (Leonardi and Armentano, 2003; DeVries et al., 2007; Leonardi and Armentano, 2007). In contrast to the dry diet, cows

Table 3. Dry matter percentage of particle fractions¹ for fresh feed and orts from both treatment diets

Item	Diet ²		SE	P-value
	Dry	Wet		
DM % of TMR particle fractions				
Long	50.1	41.2	1.2	<0.001
Medium	57.7	46.7	1.3	<0.001
Short	60.3	49.6	1.1	<0.001
Fine	59.8	52.2	0.8	<0.001
DM % of orts particle fractions				
Long	44.4	36.7	1.6	0.003
Medium	50.5	42.0	1.9	0.003
Short	52.2	44.1	1.3	<0.001
Fine	55.9	52.5	0.8	0.8

¹Particle size was determined by a Penn State Particle Separator, which has a 19-mm screen (long), 8-mm screen (medium), 1.18-mm screen (short), and a pan (fine).

²Dry = basal dry diet without water added; wet = basal dry diet plus 20% water added (DM basis).

Table 4. Effect of dietary treatments¹ on the sorting (%) of long, medium, short, and fine particles²

Particle size ³	Diet		SE	P-value
	Dry	Wet		
Long	100.7	93.4*	2.7	0.07
Medium	100.4	99.4	0.7	0.3
Short	98.7†	101.3*	0.6	0.001
Fine	101.2	104.4*	2.2	0.25

¹Dry = control diet without water added; wet = control diet plus 20% water added (DM basis).

²Sorting % = $100 \times (\text{particle size} \times \text{DM intake} / \text{particle size} \times \text{predicted DM intake})$, where n = long, medium, short, or fine particle fraction. Sorting values equal to 100% indicate no sorting, <100% indicate selective refusals (sorting against), and >100% indicate preferential consumption (sorting for). Data are averaged over 3 d for 12 cows on each treatment.

³Particle size determined by a Penn State Particle Separator, which has a 19-mm screen (long), 8-mm screen (medium), 1.18-mm screen (short), and a pan (fine).

*†Difference in sorting values from 100% expressed as † $P < 0.10$, * $P < 0.05$.

fed the wet diet sorted the TMR to a greater extent, favoring the smaller particles and refusing portions of the longer particles. The difference between the sorting of the 2 diets is not likely caused by an increased ease of sorting in the wet diet, so the addition of water clearly had some deterring effect on the consumption of long particles by the cows. The difference between these results and those of Leonardi et al. (2005) may be explained by the difference in diet composition and DM content of the diets used. Leonardi et al. (2005) used a TMR that was dryer and consisted of 30% chopped hay, whereas diets used in the present study contained no hay, utilizing haylage and corn silage as forage sources. It has been previously reported that selective refusal of long particles increases with the addition of hay to the diet (Leonardi and Armentano, 2003). The addition of water to a dry ration containing hay is likely to have a different effect on the degree of sorting of long particles than the addition of water to a wetter silage-based ration which is initially less sorted. In the present study, the long particles, primarily provided by the haylage component of the diet, were the wettest fraction of both treatment diets, having even less DM in the wet diet. As a result, these long haylage particles may have been more unpalatable in the wet diet, and easily sorted against because of their size. The short and fine particles may have been sorted for in the wet diet because these were the driest fractions of that ration.

Interestingly, cows decreased their DMI when fed the wet diet. Because milk production is positively related to DMI (Martin and Sauvant, 2002), this effect is not desirable. Although there was no difference in milk production or components between these groups, it is

Table 5. Intake of DM, nutrients, nutrient composition, and orts percentage of treatment diets¹

Item	Diet ²		SE	P-value
	Dry	Wet		
DMI, kg/d	32.8	29.6	1.4	0.03
Wet matter intake, kg/d	55.1	60.3	2.8	0.08
Feed water intake, kg/d	22.3	30.8	1.5	<0.001
NDF intake, kg/d	9.7	8.7	0.4	0.027
cNDF, ³ % of DM	29.5	29.3	0.1	0.07
Starch intake, kg/d	9.3	8.5	0.4	0.046
cStarch, ⁴ % of DM	28.2	28.6	0.1	<0.001
Orts, %	14.6	13.7	1.1	0.5

¹Data are averaged over 7 d for 12 cows on each treatment.

²Dry = control diet without water added; wet = control diet plus 20% water added (DM basis).

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

⁴cStarch = starch concentration of diet consumed = (starch intake/DMI) $\times$ 100.

possible that over a longer period it would have negatively affected milk production. Dry matter intake may be limited by ration DM content in a variety of ways, including differences in fermentation of silages (i.e., end product concentrations) because of DM content, increased bulk of feed caused by intracellular water, and increased intake of water (Robinson et al., 1990). In the present study, there was no difference in primary fermentation (i.e., of the silages) or intracellular water between rations because feed components were the same. Hence, the possible physical limitation on DMI in the present study would be increased intake of water. Many researchers have previously observed no effect of water addition on DMI (Thomas et al., 1961; Robinson et al., 1990; Leonardi et al., 2005). Alternatively, Lahr et al. (1983) noted a positive correlation between DMI and DM content of the diets, using diets at similar DM

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

Item	Diet ¹		SE	P-value
	Dry	Wet		
Milk yield, ² kg/d	37.1	36.3	1.30	0.3
Milk composition, ³ %				
Fat	3.43	3.43	0.10	0.88
Protein	3.44	3.44	0.06	0.96
Milk component yield, ³ kg/d				
Fat	1.26	1.20	0.05	0.33
Protein	1.26	1.22	0.04	0.37

¹Dry = control diet without water added; wet = control diet plus 20% water added (DM basis).

²Data are averaged over 7 d for 12 cows on each treatment.

³Data are averaged over 3 d for 12 cows on each treatment.

content to the present study and prepared similarly by adding water directly to the TMR before feeding. In studies where water was added directly to the rumen, there was no reported decrease in DMI (Thomas et al., 1961; Estrada et al., 2003), which indicates that if intake was limited in the present study by water addition, it was likely not caused by the increased intake of water itself. We can hypothesize, rather, the possibility that the water absorbed by the feed increased its weight and bulk enough to limit intake through increased rumen fill (Allen, 1996). Results of the present study lend some support to this theory. Cows consumed slightly more feed in wet weight basis on the wet diet than on the dry diet, corresponding to an increase in feed water intake. The increased intake of wet matter was not enough to compensate for the lesser DM content of the wet diet and, therefore, the lesser DMI may have been caused by filling effect of the wet diet.

The reduced DMI in the present study and that of Lahr et al. (1983) may also be a result of a change in palatability of the feed. Robinson et al. (1990), referring to the results of Lahr et al. (1983), suggested that water has little time to be absorbed by the feed when added to the TMR during mixing and may cause the feed to be less palatable, resulting in reduced intake. Although Leonardi et al. (2005) also added water directly to the TMR, palatability of their wet diet may not have been an issue because of the greater DM contents of both treatment diets used. Palatability might then be a concern when water is added to diets, similar to the one used in the current study, that are already relatively low in DM. Such diets may also have reduced palatability caused by spoilage of the TMR in the feed bunk. Even though environmental temperature was not extreme during the present study, high-moisture TMR are less stable during periods of elevated environmental temperature (Eastridge, 2006).

Reduced DMI on the wet diet also resulted in less NDF and starch intake on that diet. Such reduction in nutrient intakes may potentially limit milk production (Chase, 1993). Interestingly, because of the sorting against the greater fiber long particles and sorting for the greater starch shorter particles on the wet diet, the actual concentration of these nutrients in the consumed diet differed between treatments. Compared with the dry diet, on the wet diet, the concentration of dietary starch consumed was greater and there was a tendency for the concentration of dietary NDF consumed to be less. Such an imbalance in ration composition consumed may increase the risk of subacute ruminal acidosis because there is less fiber intake and more starch intake than predicted (Owens et al., 1998; DeVries et al., 2008).

CONCLUSIONS

Taking into consideration the reduced DMI and increased sorting, it is possible that the addition of water to a high-moisture ration changed the palatability of the feed in a way that prompted cows to consume less and eat in a more discriminating fashion. Hence, in cases where it is typical to feed high-moisture TMR, containing primarily silage and haylage forage sources, these results do not support the addition of water as a method to discourage cows from sorting. In fact, because of reduced DMI and increased sorting of such rations, the addition of water will result in the consumption of a ration with different nutrient composition than intended.

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