FEED DELIVERY AND BUNK MANAGEMENT ASPECTS OF LAMINITIS IN DAIRY HERDS FED TOTAL MIXED RATIONS

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INTRODUCTION

Lameness causes economic loss in dairy herds through prevention and treatment costs, premature culling, poor fertility, and lost milk production. Laminitis, an aseptic inflammation of the dermal layers inside the hoof and a major source of lameness in dairy herds, has been linked to lactic acidosis (Nocek, 1997).

Ruminal pH is largely a function of the balance between the production of volatile fatty acids (VFA) from the fermentation of carbohydrates, their neutralization by salivary and dietary buffers, and their removal by absorption across the rumen wall or passage from the rumen (Allen, 1997). Acidosis is caused by the consumption of diets that are high in ruminally available carbohydrates, low in effective fiber, or both (Nocek, 1997).

Formulation guidelines are available for chemical fiber (Nocek, 1997; NRC, 1989) and physically effective fiber (Mertens, 1997) minimums and nonstructural carbohydrate (NSC) and starch maximums (Nocek, 1997) in dairy cattle diets. The feeding of total mixed rations (TMR), which regulates dietary forage to concentrate ratio, is now common on commercial dairies.

Despite these advances in diet formulation and feed delivery, Nordlund (1997) and Oetzel (1997) reported that subacute rumen acidosis is a prevalent problem for commercial dairies. The purpose of this paper is to discuss feed delivery and bunk management aspects of acidosis and laminitis in dairy herds fed TMR.

FEED DELIVERY

Feed Analysis

Errors in nutrient delivery can occur because of errors in the nutrient composition assigned to feed ingredients. The use of tabular values for nutrient composition of feed ingredients can be a source of error. For example, the neutral detergent fiber (NDF) content of hominy feed in the U.S.–Canadian Tables of Feed Composition (1982) is 55% and is in error with the actual value being approximately 25% on a dry matter (DM) basis. The NDF content of corn silage in the U.S.-Canadian (1982) and NRC (1989) Tables of Feed Composition is 51%, but the average and range reported by a Wisconsin commercial forage testing laboratory (personal communication, Dairyland Laboratories, Arcadia, WI) were 42% and 30%-54% (DM basis), respectively.

Error in the nutrient analysis of feed ingredients can result from poor sampling technique on farm, infrequent feed sampling and testing, or inaccurate laboratory analyses. Variation in the layering of forages into bunker silos (i.e. alfalfa silage versus corn silage or silage of different qualities) and the relative uniformity of sample and feed removal from the face can lead to a discrepancy between the forage test and what is actually fed. Switching between silo bags before forage tests are received and a new ration is formulated can cause wide swings in nutrient delivery. To ensure consistent and accurate nutrient delivery, effort should be made to assess and control these sources of error.

Procedures are available to evaluate forage and TMR particle size in commercial testing laboratories (ANSI, 1988) or on farm (Lammers et al., 1996) and should be employed to evaluate physically effective fiber. Dietary NDF from forage should also be included in the evaluation of physically effective fiber.

The NSC content of feed ingredients is usually calculated by difference (100% - %NDF - %CP - %fat - %ash) and starch can be determined analytically by commercial testing laboratories. Concentrations of

NSC and starch in corn silage are highly variable (Hoover and Webster, 1997). Dietary NSC and starch concentrations are important parameters for evaluating ruminally available carbohydrates.

Grain type (i.e. corn versus barley versus wheat), moisture content (i.e. dry corn versus high-moisture corn), and processing method (i.e. steam flaked corn versus dry rolled corn versus ground corn) are factors which influence starch availability that should be considered in the evaluation of ruminally available carbohydrates. The ruminal availability of starch in corn is inversely related to particle size and corn can be sieved to determine its particle size (Hutjens, 1999).

Ingredient Dry Matter Adjustments

Errors in nutrient delivery can occur because of failure to routinely determine the DM content of wet ingredients and adjust the rations accordingly to maintain correct and consistent DM proportions of ingredients. This is especially true for the DM proportion of forage to concentrate.

There may also be error in the on farm determination of DM content. Considerable care and time must be taken to drive off all of the water to reach a stable endpoint weight before calculating sample DM content when using microwave-oven and Koster-tester methods or DM content will be over-estimated. Errors in calculating sample DM content or in making the necessary ration adjustments can also occur.

Ingredient Feeding Rates

Errors in nutrient delivery can occur because incorrect amounts of ingredients have been added to the TMR. This can be due to an error in communication between the nutritionist, herd manager, and the feeder. More often it is due to a feeder that free lances from the formulated ration, attempts to cover up an error by adding more or less of another ingredient later on in the batch, or simply makes an honest mistake in batch preparation.

Computer programs (i.e. Easy Feed, Feed Watch, and TMR Tracker) are now available that lock the desired recipe for each batch in the scale, record the amount of each ingredient actually added to the batch, and record the total batch amount delivered to each pen. These programs have the potential to dramatically reduce the operator error that is associated with feed mixing and delivery. They can also help ensure batch to batch and day to day consistency of the TMR.

Feeding a partial TMR or some portion of the daily allotment of forage or concentrate separate from the mix can be a large source of variation in nutrient consumption among cows within a group. Adding forage to a set mixer volume rather than a scale weight can not be done accurately enough. Floating the amount of forage that is added to the batch mix depending on the amount of feed refusal is not accurate either.

Scale error can occur and the calibration of scales should be done routinely. Faulty scales should be either fixed or replaced.

Mixing

Incorrect and inconsistent TMR mixes can arise from mismanagement of the mixing process. Sampling the bunk mix and performing a nutrient and particle size analysis can assess this. Mixing error can occur for the following reasons:

- batch size too small (common problem with transition rations)
- batch size greater than the mixing capacity of the mixer
- trying to mix too much hay in the batch (this may also cause dispensing problems)
- improper sequencing of ingredients into the mixer
- under mixing or mixing for too short a period of time (causes inadequate mixing)
- over mixing or mixing for too long a period of time (causes unmixing of some ingredients and particle size reduction of the batch mix).

It is recommended that the TMR contain 8% to 10% (as-fed basis) coarse particles or particles on the top screen of the Penn State-Nasco shaker box. Possin et al. (1995) reported coarse particle fractions of 7.6%

and 4.8% (as-fed basis) for TMR mixed for < 15 min or > 15 min, respectively, in a survey of 49 commercial dairies. They also reported TMR coarse particle fractions of 7.9% and 3.5% (as-fed basis) in low- and high-incidence herds for laminitis, respectively.

BUNK MANAGEMENT

Meal Patterns

Ruminal pH declines following meals with the rate of pH decline increasing as meal size increases and as dietary NDF concentration decreases (Allen, 1997). Bunk management practices that cause cows to eat fewer and larger meals more quickly may be associated with an increased incidence of ruminal acidosis and laminitis. Factors that can cause slug feeding of the TMR include:

- limited bunk space
- limited feed access time
- restricted feeding versus feeding for 5% to 10% refusal
- inconsistent feeding schedule
- infrequent TMR push up
- bunk competition.

The combination of limited bunk space (< .45 m per cow) and feed access time (< 16 to 20 hours per day) is worse than either situation alone. The use of lock-ups in situations of limited bunk space and feed access time exacerbates the problem, because each lock up and the cow in it takes up .61 m of bunk space. When overcrowding of free stalls coincides with limited bunk space, as is often the case, the potential for laminitis is greater because cows may spend more time standing on concrete rather than lying in stalls (Colam-Ainsworth et al., 1989).

Feeding the TMR in a drive-by bunk at 10 cm above the cow alley rather than in an elevated bunk increases salivary flow and reduces sorting (Albright, 1993), which may help reduce acidosis. Milton (1998) reported that feedlot cattle fed to a clean bunk had reduced frequency of meals (4.5 versus 8.2 meals per day) and greater average meal size (3.5 versus 1.6 kg per meal) than cattle fed ad libitum. Milton (1998) also reported that deviations of 2 to 4 hours from a normal feeding schedule greatly increased the risk of acidosis in feedlot cattle. Frequent TMR push-up may encourage cows to come to the bunk for more frequent consumption of small meals.

First lactation heifers fed in a separate group spent 10% to 15% more time eating and consumed 0.5 to 2.0 more meals per day than herdmates grouped with mature cows (Krohn and Konggaard, 1979). Adverse social effects of moving cows between groups on meal frequency, size, and duration may be observed, but usually last for only a week following the move (Grant and Albright, 1997).

Feeding an ionophore (monensin) to feedlot cattle increased meal frequency and reduced average meal size in two trials reviewed by Milton (2000). Nagaraja et al. (1987) reported that several antimicrobial feed additives, including the ionophores monensin and lasalocid, reduced lactic acid concentrations in vitro through their inhibition of the lactic acid producer *Streptococcos bovis*. Clayton et al. (1999) reported similar effects for the antimicrobial virginiamycin. Dietary supplementation of sodium bicarbonate buffers the decline in ruminal pH that is observed post feeding (Erdman, 1988). The recommended inclusion rate for sodium bicarbonate is 0.75 to 1.0% of TMR dry matter.

Sorting

Armentano and Leonardi (1999) and Martin (1999) observed extensive TMR sorting in the feed bunk in university and on-farm trials, respectively. Data on particle size of TMR and orts (ANSI, 1988) and intake indicated that cows sorted against the coarse particles (Armentano and Leonardi, 1999). This was more evident for TMR containing 40% alfalfa hay than 20% (DM basis). The variation in sorting among cows was large.

Martin (1999) determined particle size of the TMR and bunk mix (Lammers et al., 1996) at 6-hour intervals post feeding on a commercial dairy. The percents on the top screen of the Penn State – Nasco shaker box for the TMR and bunk mix at 6, 12, 18, and 24 hours post feeding were 9.3%, 13.7%, 21.5%, 27.5%, and 58.7%, respectively. Cows sorted against the coarse particles. From a projection of the coarse particle intake at each time period, it appeared that intake of coarse particles was less than predicted during hours 0 – 12 post feeding and more than predicted during hours 13 – 24 post feeding. An on-farm evaluation of sorting should include particle size determination (Lammers et al., 1996) of the TMR, bunk mix, and orts.

Factors that may make a TMR prone to sorting include:

- DM content of forage and mix
- particle size of forage and mix
- cobs in corn silage
- amount of hay added to mix
- quality of hay
- frequency of feeding
- bunk space
- feed access time.

If sorting is a problem, then one or more of the following may need to be considered:

- feeding smaller amounts of TMR more frequently
- adding less hay to the mix
- processing hay finer
- using higher quality hay
- using hay that is more pliable
- processing corn silage
- addition of water to dry TMR
- addition of a liquid-molasses product to TMR to tie up fines.

FEEDING AND MANAGEMENT OF TRANSITION COWS

Lead feeding, the practice of increasing concentrates in the TMR during the last 2 to 3 weeks prior to parturition, is a common practice on commercial dairies. Intake of excessive or minimal amounts of dietary concentrate prepartum may increase the risk of acidosis.

Excessive lead feeding may increase the risk of acidosis through reduced ruminal pH and increased lactic acid production. This probably is not a major risk factor for acidosis, because low DM intake during the transition period (Bertics et al., 1992) reduces the rate and extent of post-feeding decline in ruminal pH. Also, herd managers tend to be relatively conservative with concentrate amounts for non-lactating cows.

Minimal lead feeding may increase the risk of acidosis through a failure to increase the absorptive capacity of the ruminal papillae prior to consumption of high-energy postpartum diets. Prepartum adaptation of the microbial population in the rumen prior to consumption of high-energy postpartum diets may also be important.

Dirksen et al. (1985) reported that the cross-sectional area of ruminal papillae declined when cows were placed on a low-energy dry cow diet; the lowest point was attained 1 to 2 weeks prior to parturition. The cross-sectional area of ruminal papillae increased gradually after cows were placed on a high-energy transition diet starting 2 weeks prior to calving, but area was not maximized until 6 to 8 weeks postpartum. This result suggests that the capacity for ruminal VFA absorption is lowest during the transition period. In support of this conclusion, an absorption experiment by Dirksen et al. (1985) showed that relative VFA absorption of cows was higher after feeding a high-energy diet than a low-energy diet.

A concentrate amount of .75% of body weight or 4.5 to 5.5 kg per cow per day has been recommended for the prepartum transition TMR (Shaver, 1997; Shaver and Kurz, 2000). The guidelines of Shaver and Kurz

(2000) for an early-postpartum transition TMR (14 to 28 average days in milk) were 21% minimum NDF from forage (DM basis), 8% to 10% of particles (as-fed basis) on top screen of Penn State – Nasco shaker box, and 35% NFC (DM basis).

Bazeley and Pinsent (1984) reported that herds with a high incidence of laminitis tended to put cows through more abrupt changes at calving than low incidence herds. This underscores the importance of specific feeding and management programs that allow prepartum and early postpartum cows to adapt gradually to social, environmental, and nutritional changes. Cow comfort, ventilation, and bunk management are especially important for transition cows.

CONCLUSIONS

There is a myriad of errors in feed delivery and bunk management that can occur on commercial dairies to cause a variation in nutrient intake relative to the formulated ration. This variation is particularly evident for coarse particles that are prone to sorting in the feed bunk. Investigations of acidosis and laminitis problem herds should extend beyond the formulated rations to closely scrutinize feed delivery and bunk management practices. Formulation safety margins for carbohydrates should be increased in herds that mismanage their feed delivery and bunk management. Herds with inadequate feeding and management programs for transition cows may be at an increased risk of developing acidosis and laminitis.

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