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Effect of monensin in lactating dairy cow diets at 2 starch concentrations

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ABSTRACT

The objective of this study was to determine the effects of monensin (M) supplementation on lactation performance of dairy cows fed diets of either reduced (RS) or normal (NS) starch concentrations as total mixed rations. One hundred twenty-eight Holstein and Holstein × Jersey cows (90 ± 33 d in milk) were stratified by breed and parity and randomly assigned to 16 pens of 8 cows each in a randomized controlled trial. Pens were then randomly assigned to 1 of 4 treatments in a 2 × 2 factorial arrangement of treatments. A 4-wk covariate adjustment period preceded the treatment period, with all pens receiving NS supplemented with 18 g of monensin/t of dry matter (DM). Following the 4-wk covariate adjustment period, cows were fed their assigned treatment diets of NS with M (18 g of monensin/t), NS with 0 g of monensin/t (C), RS with M, or RS with C for 12 wk. Actual starch concentrations for the RS and NS diets were 20.4 and 26.9% (DM basis), respectively. Mean dry matter intake (DMI; 27.0 kg/d) was unaffected by the treatments. Feeding M compared with C and NS compared with RS increased milk yield by 1.3 and 1.5 kg/d per cow, respectively. Milk protein percentage and yield and lactose yield were increased and milk urea nitrogen was decreased for NS compared with RS. Feeding M increased actual and component-corrected milk feed efficiencies (component-corrected milk yield/DMI) and lactose yield and tended to increase milk urea nitrogen compared with C. Milk protein percentage was decreased for M compared with C, but milk fat percentage and yield, protein yield, and lactose percentage were unaffected by M. We observed a tendency for a starch × monensin interaction for milk feed efficiency (actual milk yield/DMI); M tended to increase efficiency more for NS than for RS. Starch and monensin had minimal effects on milk fatty acid composition and yields. Feeding RS decreased milk and protein yields, but component-corrected milk yields and feed efficiencies were similar for RS and NS. Monensin increased feed efficiency and lactation performance for both dietary starch concentrations.

Key words: dairy cow, feed efficiency, monensin, starch

INTRODUCTION

Kaiser and Shaver (2006) and Bucholtz (2006) reported that starch concentrations in diets fed to high-producing dairy herds ranged from 25 to 30% (DM basis). Increased corn prices have heightened interest in feeding reduced-starch diets. Results from short-term dairy cattle feeding trials suggest that reduced-starch diets formulated by partially replacing corn grain with high-fiber, low-starch byproduct feedstuffs may be economically feasible (Shaver, 2010). Longer term studies are needed, however, to better understand the effects of feeding reduced-starch diets on lactation performance.

In a 12-wk trial with high-producing (50 kg of milk/d) dairy cows, Gencoglu et al. (2010) reported similar milk yield, greater DMI and FCM yield, and a trend for reduced actual-milk (not corrected for components) feed efficiency for cows fed a reduced-starch (**RS**; 21% starch, DM basis) diet formulated by partially substituting soy hulls for dry ground shelled corn (**DGSC**) contained in the normal-starch (**NS**; 27% starch, DM basis) diet. Even though feed cost per kilogram of DM was reduced for the RS diet, feed cost per cow per day was greater for RS because DMI was 9% greater and actual-milk feed efficiency was 7% lower for RS compared with NS. In a subsequent trial, Ferraretto et al. (2011) reported that using a wheat middlings and whole cottonseed mixture rather than soy hulls to partially replace DGSC in the RS diet increased DMI by 8% and reduced actual-milk feed efficiency by 10% for cows fed RS compared with NS.

Firkins (1997) suggested that greater digestibility and passage rate for nonforage or byproduct NDF can allow for increased NDF intake and fill, thereby increasing the threshold for limitation of DMI by dietary NDF content (Mertens, 1987). Greater DMI for RS versus NS diets (Gencoglu et al., 2010; Ferraretto et al., 2011) may be related to reduced ruminal propionate concen-

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tration (Allen, 1997), leading to increased meal size and consequently greater DMI (Allen et al., 2009).

Monensin (**M**) is an ionophore that alters rumen microbial populations and proportion of ruminal VFA. Monensin has been shown to increase ruminal propionate, decrease DMI, and increase milk production efficiency in dairy cows (Ipharraguerre and Clark, 2003b; Duffield et al., 2008). Monensin has also been associated with decreased milk fat percentage and yield (Broderick, 2004; AlZahal et al., 2008) and changes in milk FA proportions (He et al., 2012). These changes are caused by M inhibiting FA biohydrogenation by rumen microorganisms (Fellner et al., 1997) and increased flow of *trans*-C18:1 FA to the small intestine, which inhibits mammary gland FA synthesis (Bauman and Griinari, 2001). Changes in milk fat composition with M supplementation have been reported to be influenced by dietary factors, such as NDF and NFC concentrations, and delivery method of the diet (Duffield et al., 2003). Previous studies have investigated the effect of M on lactating cows fed diets differing in forage to concentrate ratio (Ramanzin et al., 1997); however, we have found no studies that evaluated the effect of both M supplementation and dietary starch concentrations in dairy cattle. Monensin was not fed in the RS versus NS studies of Gencoglu et al. (2010) and Ferraretto et al. (2011). The objectives of the current study were to evaluate possible interactions of monensin supplementation and dietary starch content on lactation performance and milk FA composition of lactating dairy cows. Our hypothesis was that monensin supplementation would reduce DMI and improve milk production efficiency more with RS than with NS diets. This response could expand the economic opportunities for feeding RS diets to high-producing dairy cows when economically advantageous.

MATERIALS AND METHODS

Cows and Treatments

The experimental protocol was approved by the Animal Care and Use Committee of the College of Agriculture and Life Sciences at the University of Wisconsin-Madison. One-hundred twenty-eight cows (90 ± 33 DIM) were stratified by breed (Holstein and Holstein × Jersey crossbred) and parity (primi- and multiparous), and randomly assigned to 16 pens of 8 cows each in a randomized controlled trial in the University of Wisconsin-Madison Emmons-Blaine Arlington freestall, milking parlor dairy facility. Each pen consisted of 3 primiparous Holstein, 3 multiparous Holstein, and 2 multiparous Holstein × Jersey crossbred cows. Pens were randomly assigned to 1 of 4 treatments with 4 pens per treatment in a 2 × 2 factorial arrangement of treatments with 2 dietary starch concentrations (**S**; 21% vs. 27% of DM for RS and NS, respectively) and 2 dietary concentrations of monensin (Rumensin, Elanco Animal Health, Greenfield, IN) supplementation [control (**C**) and M at 0 and 18 g/t of DM, respectively] as main effects for a continuous lactation experiment. Randomization was done by randomly drawing paper slips numbered 1 to 16 to assign cows to pens and paper slips labeled with the treatment name to assign treatments to pens. The number of pens per treatment was determined using standard deviations of data from previous continuous lactation studies done in these pens and the difference between treatments to be detected. Using differences of 1 kg for DMI, 1.5 kg for milk yield, and 0.2 percentage units for milk fat content, an α error level of 0.05, and a β error level of 0.20, the number of pens needed was 8 for the main effects of starch and monensin. Treatments were blinded to the milking staff but not to the study investigators, herd management staff, or feeding staff. The lack of treatment blinding was not anticipated to affect results in this study. The RS diet was formulated by partially replacing DGSC with pelleted soy hulls. All cows were receiving 11 g of monensin/t of DM before the start of the 4-wk covariate period. During the 4-wk covariate period, all cows were fed the NS diet with 18 g of monensin/t of DM (**NS-M**) followed by a 12-wk treatment period with cows fed their assigned treatment diets of NS-M, NS with 0 g of monensin/t of DM (**NS-C**), RS with 0 g of monensin/t of DM (**RS-C**), and RS with 18 g of monensin/t of DM (**RS-M**). Ingredient composition of the diets is provided in Table 1 and that of the grain mixes and treatment premixes is provided in Table 2. On d 1 of the treatment period, pens assigned NS-C and RS-C were switched to 0 g of monensin/t of diet DM, whereas the other pens continued to receive 18 g of monensin/t of diet DM. All cows were commingled for the first 2 wk of the covariate period and then assigned to their respective 8-cow pens for the second 2 wk of the covariate period and the 12-wk treatment period. All cows received bovine somatotropin (Posilac, Elanco Animal Health) every 14 d starting at 57 to 70 DIM, with all cows on bST by d 15 of the covariate period.

Diets were fed as TMR mixed and fed once daily. The M or C premixes (Vita Plus Corp., Madison, WI) were added to the TMR separately from the concentrate mixtures to provide an average intake of 227 g/cow per day. The pens were supplied with TMR to allow for 5% refusals, with daily DMI determined on a pen basis throughout the study. Control pens received their daily feed allotment first, followed by the monensin treatment pens. Daily pen refusals were recorded each morning before new feed delivery using feeding

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