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Lactational performance of Holstein dairy cows fed 3 concentrations of full-fat corn dried distillers grains with solubles

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ABSTRACT

Our objective was to evaluate production performance of lactating Holstein dairy cows fed 3 different dietary concentrations of full-fat dried distillers grains with solubles (DDGS; 13.6% fat, DM basis). Thirty cows were fed 0, 10, and 20% DDGS DM as a TMR in a 3 × 3 crossover. Cows were stratified into groups of 10 by parity and DIM and fed each of 3 diets in three 28-d periods. Based on our prior research, we hypothesized that feeding 20% DDGS (DM basis) would negatively influence production and feed efficiency of dairy cattle. Effect of DDGS on DMI was inconsistent; the control and 20% DDGS diets were equivalent and the DMI of cows fed 10% DDGS was lower than both. Milk yield was not affected by treatment, but there was a linear depression in milk fat percentage, milk yield, and yield of 3.5% FCM and energy-corrected milk (ECM) with increasing DDGS in the diet. Both protein and lactose percentages increased when cows were fed DDGS; neither protein nor lactose yield, however, was affected. Protein efficiency, a measure of the use of dietary protein for milk protein synthesis, decreased for cows fed 20% DDGS, possibly resulting from differing amounts of metabolizable lysine. All 3 measures of energetic efficiency [ECM/DMI, kg of ECM/NE_l intake (Mcal), and GE of milk produced (Mcal)/NE_l caloric intake (Mcal)] decreased when cows were fed 20% DDGS but not when cows were fed 10% DDGS. These results indicate that, with the exception of an approximate loss of milk fat by 0.5 percentage points, full-fat DDGS used in this study can be effectively fed at 10% without a loss in production performance when compared with a control diet not containing DDGS. Feeding the full-fat DDGS at 20%, however, is not advisable.

Key words: total mixed ration, feed efficiency, feed intake, milk, milk fat depression

INTRODUCTION

An important consideration when choosing any feed ingredient to include in a ration is the influence that the feed ingredient has on the productivity of the food-producing animal. Recently, increased ethanol production from corn in the Midwest has resulted in the increased availability of distillers grains and co-products. Moreover, dried distillers grains with solubles (**DDGS**) are often an economical protein source for animal production. Dried distillers grains with solubles are also a good source of RUP (Firkins et al., 1984; Powers et al., 1995) in the ration of a lactating dairy cow. Prior research has indicated that DDGS can effectively be fed to lactating dairy cows without changing DMI or milk fat percentage while either not affecting or in some cases increasing yield of milk, yield of energy-corrected milk (**ECM**), fat, protein, and feed efficiency when compared with a traditional TMR not containing DDGS when forage is held constant (Anderson et al., 2006; Kleinschmit et al., 2006; Havlin et al., 2015). Conversely, our prior research showed decreased milk fat percentage and milk yield when cows were fed 25% DDGS with 12.1% fat (Testroet et al., 2015). Additionally, composition and nutritional value of DDGS can be highly variable, depending on manufacturing practices (Spiehs et al., 2002), even within the same ethanol plant (Belyea et al., 2004). As the ethanol industry has matured, however, so has the realized value of DDGS as a co-product rather than as a by-product. Consequently, ethanol production plants have developed more consistency in the nutritional quality of DDGS they produce. Therefore, it was the objective of this study to investigate the effects of feeding full-fat DDGS produced with current manufacturing practices on the feed efficiency and production performance of lactating Holstein dairy cows. In addition, based on our prior research, we hypothesized that feeding full-fat DDGS at 20% of dietary DM to lactating dairy cattle would negatively influence the production and efficiency of dairy cows when compared with diets containing 0 or 10% of DM as DDGS.

MATERIALS AND METHODS

Animals and Diets

All experimental protocols were approved by the Iowa State University Institutional Animal Care and Use Committee before commencement of the study. Thirty mid-lactation (164.4 ± 16.2 DIM), multiparous Holstein cows

The authors declare no conflict of interest.
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were fed diets containing 0, 10, or 20% corn DDGS (Heartland Cooperative, Prairie City, IA). Cows were assigned randomly to 1 of 3 treatment sequences in a 3 × 3 crossover design. Diets were formulated to be isonitrogenous (16.5% protein) and isoenergetic (Table 1). Samples of experimental diets were collected and pooled over a period of 3 d from both daily feedings during wk 3 and 4 of each experimental period. Experimental diets were then combined, randomly sampled, and sent to Dairylands Laboratory (Arcadia, WI) for chemical analyses by wet chemistry methods and fatty acid analysis by gas chromatography. Feed composition is represented as the mean of 6 samplings and presented in Table 2, showing that, as designed, no differences in CP and estimated NE_l exist. Fiber (acid detergent) was determined by AOAC Official Method 973.18 (1996) and lignin by AOAC Official Method 973.18 (AOAC International, 2000), ether extract was determined by using AOAC Official Method 945.16 and AOAC Official Method 920.39, feed fatty acids were quantified by using the method described by Pritam and Palmquist (1988), nitrogen was quantified by using AOAC Official Method 990.0, minerals were determined by inductively coupled plasma mass spectrometry by using AOAC Official Method 985.0 and AOAC Official Method 2011.14, NDF was determined as described by Mertens (2002), acid detergent insoluble CP was determined by using AOAC Official Method 973.18 and AOAC Official Method 990.03, ash was determined by AOAC Official Method 942.05, and finally DM was determined by using National Forage Testing Association Method 2.1.4. Although rations were formulated to contain 16.5% protein, the 10% DDGS ration contained 0.5 percentage points more protein than did the control ration. Cows were housed at the Iowa State University Dairy Farm (Ames, IA) together in a 48-cow, free-stall pen and individually fed there twice daily (0700 and 1700 h) with a Calan Data Ranger (American Calan Inc., Northwood, NH) to allow for approximately 15% refusal. Feed ingredients in a TMR were mixed before being loaded onto the Data Ranger by using a Patz V615 mixer (Patz Corporation, Pound, WI). Cows were allowed ad libitum access to food and water, except for 3 times daily during which they were being milked (8 h apart). Initially, cows were allowed 7 d to adapt to using the Calan gates (American Calan Inc.). For each 28-d experimental period, the data from the first 13 d of each 28-d experimental period were used as a washout and excluded from the analysis to limit carryover effects.

Milk Yield and Composition

Total milk yield was recorded daily using an automatic weighing milking system (Boumatic, Madison, WI). During each period, on d 14, 21, and 28, individual milk samples were collected automatically from each milking to represent one complete milking (i.e., a 24-h period) by the Boumatic milking system. Milk samples (30 to 40 mL at 22 ± 2°C) then were transported immediately to a campus laboratory for component analyses in duplicate by using a Lacticheck-01 RapiRead Milk Analyzer (Page & Pedersen Intl. Ltd., Hopkinton, MA). Analyzed components include percentage fat, protein, and lactose.

Statistical Analyses

Statistical analyses of milk composition, yield, and feed efficiency were performed by using SAS version 9.3 (Cary, NC) and Proc MIXED. Data were analyzed as a 3 × 3 crossover design. The model included 3 fixed effects (sequence, period, and treatment) and cow(sequence) as a random effect. Linear and quadratic contrasts also were performed. When significant quadratic effects were found, means were separated by using an F-protected LSMEANS test. Feed fatty acid composition is presented as the mean of 6 samplings with the associated standard deviation.

RESULTS AND DISCUSSION

To evaluate the effect of feeding DDGS on feed efficiency and milk production, Holstein cows were fed DDGS at 3 different concentrations. To satisfy the requirements of a crossover design, the 5 cows that were removed from the trial because of illness (e.g., mastitis) were not included in data analyses. Dry matter intake (Table 3) was affected in a quadratic manner by dietary treatments, where DMI for cows fed the 0 and 20% DDGS was greater than the DMI of cows fed 10% DDGS. Similar previous studies have reported no change in DMI for cows fed 10 and 20% DDGS DM when forage was held constant (Anderson et al., 2006; Kleinschmit et al., 2006). To maintain isoenergetic and isonitrogenous diets, the ingredient composition of the control and 10% DDGS rations had to be altered (Table 1). In particular, SoyPlus (West Central Cooperative, Ralston, IA) was replaced with DDGS, and the 0 and 10% diets contained Supercharger (a tallow-based supplement; Origo, New Ulm, MN), whereas the 20% diet contained tallow. The reason for the different fat sources was because a custom concentrate mix had to be formulated for the 20% DDGS ration to maintain the nutritional equivalence of the diets. It is possible that the changes in ingredient composition, particularly the increased NDF, which has been used as a predictor of intake, in the 10% DDGS diet (Table 2) can explain the quadratic response of DMI.

Milk yield (Table 3) was unaffected by treatment. However, both 3.5% FCM and ECM (Table 3) were decreased linearly as DDGS increased from 0 to 20%. These results are supported by findings reported by Testroet et al. (2015), who maintained similar forage levels in the rations and also reported a decrease in milk fat percentage in cows fed both 10 and 25% full-fat DDGS (DM basis). The decrease in FCM and ECM could be related to (1) inhibition of fiber digestion by increasing dietary fat (fat percentages: 0% DDGS was 5.6% fat, 10% DDGS was 6.9% fat, and 20% DDGS was 7.6% fat; Table 2), (2) inhibition of fat synthesis in the mammary gland, (3) both