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Ration formulations containing reduced-fat dried distillers grains with solubles and their effect on lactation performance, rumen fermentation, and intestinal flow of microbial nitrogen in Holstein cows

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ABSTRACT

Sixteen multiparous lactating Holstein cows were used in 2 experiments to evaluate the effects of reduced-fat dried distillers grains with solubles (RFDG) on milk production, rumen fermentation, intestinal microbial N flow, and total-tract nutrient digestibility. In experiment 1, RFDG was fed at 0, 10, 20, or 30% of diet dry matter (DM) to 12 noncannulated Holstein cows (mean ± standard deviation: 89 ± 11 d in milk and 674 ± 68.2 kg of body weight) to determine effects on milk production. In experiment 2, the same diets were fed to 4 ruminally and duodenally cannulated Holstein cows (mean ± standard deviation: 112 ± 41 d in milk; 590 ± 61.14 kg of body weight) to evaluate the effects on rumen fermentation, intestinal flow of microbial N, and total-tract nutrient digestibility. In both experiments, cows were randomly assigned to 4 × 4 Latin squares over 21-d periods. Treatments (DM basis) were (1) control (0% RFDG), (2) 10% RFDG, (3) 20% RFDG, and (4) 30% RFDG. Feed intake and milk yield were recorded daily. In both experiments, milk samples were collected on d 19 to 21 of each period for analysis of milk components. In experiment 2, ruminal pH was measured; samples of rumen fluid, duodenal digesta, and feces were collected on d 18 to 21. Microbial N was estimated by using purines and DNA as microbial markers. Milk yield was not affected by treatment and averaged 34.0 ± 1.29 kg/d and 31.4 ± 2.81 kg/d in experiments 1 and 2, respectively. Percentage of milk protein tended to increase in experiment 1; estimates were 3.08, 3.18, 3.15, and 3.19 ± 0.06% when RFDG increased from 0 to 30% in the diets. However, milk protein concentration was not affected in experiment 2 and averaged 3.02 ± 0.07%. Percentage of milk fat was not affected and averaged 3.66 ± 0.05% and 3.25 ± 0.14% in experiments 1 and 2, respectively. Total ruminal volatile fatty acids and ammonia concentrations were not affected by treatment and averaged 135.18 ± 6.45 mM and 18.66 ± 2.32 mg/dL, respectively. Intestinal microbial N flow was not affected by treatment; however, purines yielded higher estimates of flow compared with DNA markers. When averaged across treatments, intestinal flow of microbial N was 303 and 218 ± 18 g of N/d, using purines and DNA as the markers. Dry matter, organic matter, neutral detergent fiber, and nonfiber carbohydrate digestibility tended to increase with increasing inclusion of RFDG. Results from these experiments indicate that dairy rations can be formulated to include up to 30% RFDG while maintaining lactation performance, volatile fatty acids concentration, and intestinal supply of microbial N.

Key words: distillers grains with solubles, lactation, intestinal microbial N, total-tract nutrient digestibility

INTRODUCTION

Over the last decade, the supply of corn milling byproducts such as dried distillers grains with solubles (**DDGS**) has increased (Klopfenstein et al., 2008; Schingoethe et al., 2009). Over that time, extensive research has been conducted to evaluate the effect of this byproduct on lactational performance of dairy cows. A wide array of publications has reported that DDGS can be effectively fed to dairy cows while maintaining milk yield and composition. For example, Ranathunga et al. (2010) reported that, compared with a control diet, the inclusion of 21% DDGS in the ration had no negative effect on milk production or composition. Furthermore, Janicek et al. (2008) reported a linear increase in milk production when DDGS were included from 0 to 30% in dairy diets. Anderson et al. (2006) demonstrated that dairy rations may contain up to 20% DDGS, replacing an equal amount of both ground corn and soybean

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meal, and maintain or enhance milk production. Further research is needed to study effects not only on lactation performance, but also on rumen parameters, nutrient utilization, and intestinal microbial N supply. Recently, the corn milling industry has found new uses for corn oil, which is partially removed from the solubles stream by physical and chemical techniques (e.g., centrifugation or solvent extraction; Majoni et al., 2011); the resulting byproduct is commonly referred to as reduced-fat DDGS (**RFDG**; Mjoun et al., 2010a). With centrifugation technology, the RFDG product contains approximately 5.5% fat. Although the loss of fat may result in a product with less energy, it also contains a lower concentration of PUFA and thus may also lower the potential risk for the development of milk fat depression (Bauman and Griinari, 2003).

Several experiments have evaluated the effect of DDGS on microbial crude protein (**MCP**) synthesis. For example, Kelzer et al. (2009) reported that MCP synthesis was similar for cows fed a control diet with no DDGS, a diet containing 15% DDGS, or a diet containing 15% high-protein DDGS. Chibisa et al. (2012) demonstrated that wheat DDGS may substitute for canola meal as the major protein source in dairy cow diets without negatively affecting MCP production. Furthermore, Janicek et al. (2008) reported that MCP synthesis of cows consuming 30% DDGS was similar compared with those consuming a diet containing no DDGS. Most of these studies have measured MCP by using purine derivatives as a microbial marker and measuring the concentration of this marker in the urine. Although the use of purine derivatives represents a noninvasive method to predict microbial N flow (Harmon and Richards, 1997), one limitation of using this method is thought to be the limited accuracy of the equations for prediction purposes (Firkins et al., 2006). In the present study, microbial N flow was measured in 2 ways: by the use of either purine bases or DNA as microbial markers. The objectives of these experiments were to evaluate the effects of increasing levels of RFDG on lactation performance, rumen fermentation, intestinal flow of microbial N, and total-tract nutrient digestibility; and second to compare the estimates of microbial N using purine bases or DNA as microbial markers. We hypothesize that RFDG can be included in dairy rations with no negative effects on lactation performance, rumen fermentation, intestinal flow of microbial N, or total-tract nutrient digestibility.

MATERIALS AND METHODS

This study was composed of 2 separate experiments. Experiment 1 was conducted to evaluate the effects of RFDG on lactation performance and was conducted at the Agriculture Research and Development Center of University of Nebraska-Lincoln (Mead). Experiment 2 was conducted to evaluate the effects of RFDG on rumen parameters, intestinal supply of microbial N, and total-tract nutrient digestibility and was conducted in the Dairy Metabolism Facility located in the Animal Science Complex of University of Nebraska-Lincoln (Lincoln). All experimental procedures were approved and cows were cared for according to the guidelines stipulated by the University of Nebraska Institutional Animal Care and Use Committee.

Experiment 1: Experimental Design, Animal Care, and Sampling

Twelve lactating multiparous Holstein cows (mean and SD, 89 ± 11 DIM and 674 ± 68.2 kg of BW) were blocked by milk yield and DIM and randomly assigned to treatment sequences in replicated balanced 4 × 4 Latin squares according to the method of Kononoff and Hanford (2006) with 21-d periods. The first 14 d of each period were considered an adaptation period and the remaining 7 d were used for data collection. Cows were housed in individual tiestalls equipped with rubber mats and were offered 1 of 4 treatments that differed by the level of RFDG (Poet Nutrition, Sioux Falls, SD) inclusion: (1) control (**CON**), 0% RFDG; (2) 10% RFDG; (3) 20% RFDG; and (4) 30% RFDG. The reported chemical composition of treatments is based upon analyzed chemical composition of individual feed ingredients. Treatments were formulated with the CPM-Dairy model (version 3.0.8.1; Cornell University, Ithaca, NY; University of Pennsylvania, Kennett Square, PA; and William H. Miner Agricultural Research Institute, Chazy, NY). A diet (CON) not containing RFDG was formulated and designed to be representative of a diet fed in the Great Plains of the United States. Then, a portion of forage, corn, cottonseed, and soy-based feeds were reduced to reach the greatest inclusion of RFDG, 30% of diet DM. Practically, formulations that substitute several ingredients are common when attempts are made to include byproducts. Consequently, formulations were similar in CP but the inclusion of RFDG resulted in a lower concentration of energy, as estimated by the CPM-Dairy model.

Cows were milked using a double-5 herringbone parlor (BouMatic LLC, Madison, WI) at 0730 and 1930 h, milk production was recorded, and milk samples were collected during the a.m. and p.m. milkings of d 19, 20, and 21. Milk samples were stored at room temperature in a vial containing a preserving pellet (2-bromo-2-nitropropane-1,3 diol,) provided by the DHIA (Manhattan, KS). Samples were then analyzed for fat, lactose, and true protein by near-infrared spec-

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