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Continuous 11-week feeding of reduced-fat distillers grains with and without monensin reduces lactation performance of dairy cows

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ABSTRACT

This study investigated the effects of continuous feeding of high inclusion of reduced-fat corn distillers grains with solubles with and without monensin on dry matter intake (DMI), production, milk fatty acid profile, and plasma AA profile in lactating cows. The experiment was conducted for 12 wk (1-wk covariate, 2-wk diet adaptation, and 9-wk experimental period of data collection) with 36 Holstein cows in a randomized complete block design. Cows were blocked by parity, days in milk, and milk yield and assigned to the following diets: (1) control (CON), (2) CON with reduced-fat corn distillers grains with solubles included at 28.8% (dry matter basis) replacing soybean meal, soyhulls, and supplemental fat (DG), and (3) DG with monensin (Rumensin; Elanco Animal Health, Greenfield, IN) supplemented at a rate of 20 mg/kg of DM offered (DGMon). Orthogonal contrasts were used to compare CON versus DG and DGMon and to compare DG versus DGMon. Milk yield was not affected (40.3 vs. 40.8 kg/d) by DG and DGMon compared with CON. However, for DG and DGMon compared with CON, decreased DMI (24.9 vs. 26.4 kg/d), milk fat yield (1.12 vs. 1.55 kg/d), milk protein yield (1.24 vs. 1.32 kg/d), and energy-corrected milk yield (37.7 vs. 43.5 kg/d) were observed. Feeding DGMon compared with DG did not affect DMI (24.4 vs. 25.4 kg/d) and milk yield (39.2 vs. 41.3 kg/d) but decreased milk fat yield (1.08 vs. 1.23 kg/d), milk protein yield (1.20 vs. 1.28 kg/d), and energy-corrected milk yield (36.0 vs. 39.4 kg/d). Interactions between treatment and week for DMI, milk fat yield, and energy-corrected milk indicate that production responses to DG and DGMon versus CON were decreased over the experimental period. Cows fed DG and DGMon had increased milk fat concentration of *trans*-10,*cis*-12 18:2, *trans*-10 18:1, and long-chain (>16C) and polyunsaturated fatty acids and decreased short-chain (<16C) and odd- and branched-chain fatty acids compared with CON. No difference was observed between DG and DGMon in milk fatty acid profile. In the current study, feeding a high-DG diet did not sustain DMI and production, and supplementing monensin to a high-DG diet further decreased DMI and production.
Key words: reduced-fat distillers grains, monensin, performance, dairy cow

INTRODUCTION

In past decades, the push for alternative fuel sources has resulted in an increase in ethanol production, primarily from corn, subsequently increasing production of co-products (Renewable Fuels Association, 2017). The most common co-product is corn dried distillers grains with solubles (**DDGS**). Because of their low cost, feeding a diet containing high DDGS to dairy cows can be economical (Ranathunga et al., 2010). However, concerns over protein quality, particularly Lys deficiency, arise when DDGS are substituted for soybean meal (**SBM**; Paz et al., 2013; Paz and Kononoff, 2014) due to low Lys content of corn products (NRC, 2001). Additionally, because traditional DDGS contain high concentrations of fat and PUFA, milk fat depression has occurred in various studies when DDGS are fed at 30% of diet DM (Benchaar et al., 2013; Ramirez-Ramirez et al., 2016). Recently, the ethanol industry has adapted methods to extract oil from the co-product stream (Majoni et al., 2011). This extraction decreases crude fat of DDGS by 40 to 60%, resulting in production of reduced-fat DDGS (**RFDG**) with a crude fat of 5.5 to 7.5% (DM basis; DuFour, 2017). Although a risk of Lys deficiency with high-RFDG diets still exists, RFDG are suggested to decrease the risk of milk fat depression compared with DDGS (Ramirez-Ramirez et al., 2016).

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Previous studies indicated that RFDG can be included in a ration for lactating cows up to 30% of dietary DM and maintain or increase DMI, milk yield, and milk fat and protein yield (Castillo-Lopez et al., 2014; Ramirez-Ramirez et al., 2016). However, these studies were short-term experiments (Latin square designs). Production responses to dietary modification can be different according to the experimental length and designs. For example, recovery from milk fat depression can take 2 to 3 wk (Weiss, 2012; Rico and Harvatine, 2013). This suggests that using 3 wk per period in a Latin square design may not be sufficient to evaluate milk fat depression caused by dietary modification. In agreement, Benefield et al. (2009) indicated that treatment sequence can influence milk fat production in a Latin square design. In addition, Hristov and Giallongo (2014) suggested that longer-term studies (e.g., 10-wk randomized complete block design) are needed to assess production responses to dietary protein modification because labile AA might compensate for short-term nutritional deficiencies. A recent meta-analysis by Zanton (2016) also indicated that production responses to changing dietary protein content differed between continuous and change-over experimental designs. Therefore, a continuous longer-term study might be necessary for accurate evaluation of production responses to high-RFDG diets. To our knowledge, very few studies were conducted with RFDG in the long term. A continuous 12-wk study reported that feeding RFDG at 20% of diet DM replacing SBM and soyhulls did not negatively affect milk protein and fat production of lactating cows (Mjoun et al., 2010a). In this study, however, the fat content of RFDG was only 3.5% (DM basis), which does not represent current RFDG (5.5–7.5% fat). Therefore, evaluation of production responses to a high-RFDG (about 30% of DM) ration in a continuous longer-term study is needed.

Monensin is a feed additive commonly fed to dairy cattle, and a meta-analysis by Duffield et al. (2008b) indicated that monensin increased production efficiency, milk yield, and milk protein yield by 2.5, 2.3, and 1.9%, respectively, partly due to increased total-tract N digestibility (Ruiz et al., 2001; Martineau et al., 2007). However, Duffield et al. (2008b) observed a decrease in milk fat concentration when monensin was fed to dairy cows, and milk fat depression was exacerbated with monensin when dietary PUFA content increased (AlZahal et al., 2008). Although RFDG and monensin are widely included in dairy rations, the effects of the combination of RFDG and monensin on milk fat yields have not been studied. Therefore, the objective of this experiment was to determine the 11-wk continuous production responses of lactating dairy cows fed a diet with high RFDG, fully replacing SBM, with and without monensin. The hypothesis was that a diet with about 30% RFDG (DM basis) will negatively affect milk fat yields in the long term and that the addition of monensin to a high-RFDG diet may exacerbate milk fat depression.

MATERIALS AND METHODS

Animals and Treatments

Animal care and procedures were approved by The Ohio State University Institutional Animal Care and Use Committee. The cows used were not fed monensin for at least 6 mo before starting the experiment.

The experiment was carried out at the Ohio Agricultural Research and Development Dairy Center (Wooster, OH) in a randomized complete block design using 36 Holstein cows (9 primiparous and 27 multiparous; average ± SD at the beginning of the trial: milk yield, 44.2 ± 8.1 kg/d; DIM, 80 ± 31; BW, 675 ± 74 kg). Cows were blocked by parity, DIM, and milk yield, and cows in each block were randomly allocated to 1 of 3 treatment diets: (1) a lactating cow ration not containing RFDG or monensin (control diet; **CON**; Table 1); (2) the CON diet containing RFDG (28.8% of diet DM) replacing SBM, soyhulls, and supplemental fat (**DG**); and (3) the DG diet with monensin (Rumensin; Elanco Animal Health, Greenfield, IN) supplemented at a rate of 20 mg/kg of DM offered (**DGMon**). All diets were formulated to be isonitrogenous and isoenergetic and meet or exceed nutrient requirements according to NRC (2001).

The experiment was conducted for 12 wk (1-wk covariate period, 2-wk diet adaptation period, and 9-wk experimental period; wk 1 through 9 refers to the 9-wk experimental period from here on). To allow the rumen microbiota to adapt to monensin, the inclusion rate of monensin for DGMon was half of the target rate (i.e., 10 mg/kg of DM) during the first week of the diet adaptation and increased to 20 mg/kg of DM at the start of wk 2. Prior to the experiment, all cows had received the lactating herd ration [% of DM: corn silage, 38.5; alfalfa silage, 8.8; corn grain, 24.5; SBM, 10.0; cottonseed, 8.8; AminoPlus (Ag Processing Inc., Omaha, NE), 3.1; soyhulls, 3.1; animal–vegetable fat, 0.4; minerals and vitamins, 2.8] since calving, and the same diet was fed to all cows during the covariate period. Approximate nutrient composition for the covariate diet was (% of DM) CP, 17.1; NDF, 29.3; and ether extract, 5.2. Cows were housed in individual tiestalls with free access to water and fed TMR once daily with a target refusal rate of 5%.