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Growth performance, rumen fermentation, nutrient utilization, and metabolic profile of dairy heifers limit-fed distillers dried grains with ad libitum forage

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ABSTRACT

The objective of this study was to determine the effects of feeding a corn- and soybean-product-based concentrate mix or distillers dried grains with solubles concentrate mix with ad libitum grass hay to dairy heifers. A 16-wk randomized complete block design study was conducted using 24 heifers [18 Holstein and 6 Brown Swiss; 219 ± 2 d of age (±standard deviation); 230 ± 4 kg of body weight] to evaluate the effect of diet on dry matter intake (DMI), growth performance, rumen fermentation, metabolic profile, and nutrient digestibility. Treatments were (1) corn and soybean product concentrate mix, and (2) distillers-dried-grains-with-solubles-based concentrate mix (DDG). Both concentrate mixes were limit-fed at 0.8% of body weight and grass hay was offered ad libitum. Heifers were individually fed using Calan gates and orts were recorded daily at feeding. Heifers were weighed every 2 wk and ration concentrate mix offered was adjusted accordingly. Frame measurements and body condition score were recorded every 2 wk. Rumen fluid was collected via esophageal tubing during wk 12 and 16 for pH, ammonia N, and volatile fatty acid analysis. Jugular blood samples were collected every 4 wk for metabolite and metabolic hormone analysis. Total-tract digestibility of nutrients was evaluated during wk 16 by fecal grab sampling. No treatment by week interactions were observed for any of the growth measurements and growth measurements and DMI did not differ between treatments. A treatment by time interaction was observed for rumen butyrate percentage with heifers fed DDG having a greater percentage. Total volatile fatty acid concentration, acetate molar percentage, and acetate:propionate decreased with the DDG treatment, whereas propionate molar percentage increased. No treatment by week interactions were observed for any of the metabolites or metabolic hormones measured. A tendency was observed for glucose and plasma urea nitrogen concentration to decrease with DDG. Plasma cholesterol and insulin increased with DDG. Results demonstrated that limit-feeding heifers DDG at 0.8% of body weight with ad libitum grass hay maintained growth performance, average daily gain, DMI, and gain:feed, with shifts in the metabolic profile compared with the corn and soybean product concentrate mix.
Key words: distillers grains, dairy heifer, growth performance

INTRODUCTION

Previous research has demonstrated that distillers dried grains with solubles (**DDGS**) can improve gain:feed and maintain growth performance and ADG when limit-fed or fed ad libitum in a TMR to growing dairy heifers (Schroer et al., 2014; Anderson et al., 2015a; Manthey et al., 2016, 2017). However, relatively little research has focused on limit-feeding a DDGS-based concentrate mix compared with a corn- and soybean-product-based concentrate mix with ad libitum grass hay.

Feeding high-fiber feedstuffs to growing dairy heifers may decrease diet digestibility (Zanton and Heinrichs, 2008). Utilizing a limit-feeding strategy, in which nutrient-dense diets are fed to meet but not exceed nutrient requirements, reduces DMI and also has the potential to increase nutrient digestibility while maintaining growth performance (Hoffman et al., 2007; Zanton and Heinrichs, 2009; Anderson et al., 2015a). Anderson et al. (2015a) demonstrated that limit-feeding diets high in DDGS improved CP, NDF, and ADF digestibility when compared with a corn- and soybean-product-based control concentrate mix; however, the forage was also limit-fed in these diets. That same study also demonstrated DDGS fed as part of a limit-fed ration maintained growth performance of dairy heifers compared with the control diet (Anderson et al., 2015a). In addition, research by Manthey et al. (2016) demonstrated that feeding DDGS at increasing inclusion proportions in limit-fed diets could also maintain heifer growth performance and improve gain:feed. However,

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very limited research is available examining the effects of limit-feeding a corn- and soybean-product-based concentrate mix and DDGS-based concentrate mix with ad libitum forage.

Therefore, the main objective of this study was to determine the effects of limit-feeding a corn- and soybean-product-based concentrate mix compared with DDGS with ab libitum grass hay on DMI, growth performance, rumen fermentation, metabolic profile, and nutrient digestibility. We hypothesized that heifers fed DDGS would have improved gain:feed because of a slightly greater dietary fat concentration, causing the heifers to eat less hay, but growth performance would be maintained.

MATERIALS AND METHODS

All procedures and animal use were approved before the start of the feeding study by the South Dakota Institutional Animal Care and Use Committee.

Experimental Design

Twenty-four heifers [18 Holstein and 6 Brown Swiss; 219 ± 2 d of age (±SD); 230 ± 4 kg of BW] were used in a randomized complete block design with 2 treatment diets. Heifers were blocked in groups of 2, based on breed, birth date, and BW. Heifers were randomly assigned to treatment within blocks. Heifers were added to the study based on farm calving rates and were introduced in multiples of 6 with a target start age of 7 mo. Heifers were acclimated to the barns and feeding system for approximately 2 wk followed by an experimental feeding period of 16 wk.

Treatment diets (Table 1) were (1) corn and soybean product concentrate mix (**CON**), and (2) DDGS-based concentrate mix (**DDG**). Both concentrate mixes were limit-fed at 0.8% of BW (DM basis) and grass hay was fed ad libitum. Diets were formulated using the NRC (2001) to meet a target ADG of 0.8 kg/d when fed to a 250 kg of BW Holstein heifer and to provide similar protein and energy intakes. The 250 kg of BW was a pre-estimated average BW for heifers during the study based on age and herd data. On the last 2 d of each 2-wk interval, heifers were weighed. Dry matter analysis of feedstuffs was also performed at this time and amount of concentrate mixes offered was adjusted for the next 2 wk based upon heifer BW and DM analysis of feedstuffs.

To avoid variation in production within plant and over time, DDGS was purchased in one batch and stored at the South Dakota State University Dairy Research and Training Facility. The corn and soybean product concentrate mix was mixed in 0.91-t batches at the South Dakota State University feed mill as needed throughout the feeding period. Hay was purchased in one batch.

Animal Care and Feeding

This study was conducted at the South Dakota State University Dairy Research and Training Facility (**DRTF**; Brookings, SD). The study was completed from March 2015 through September 2015 to accommodate available animals and pen space. Heifers were observed daily for health problems and treated according to routine management practices at the DRTF. As part of the routine South Dakota State University DRTF herd management, all Holstein heifers were genomically tested through services provided by Zoetis Inc. (Parsippany, NJ) in cooperation with the Holstein Association USA (Brattleboro, VT). For the testing, hair samples with root balls were collect from heifers within 2 mo of birth. Samples were sent to Zoetis Services Laboratory (Kalamazoo, MI) to be analyzed as part of the Clarifide platform. The DNA was extracted on a 19K chip and calculations for PTA and indexes were performed by the Council for Dairy Cattle Breeding (Bowie, MD). Individual heifer data were summarized and provided for download through the Enlight web portal (https://www.enlightdairy.com).

Heifers were housed in pens of 6 heifers each. Each pen had an inside roofed area (7 m × 4 m) and an outside dirt exercise lot (7 m × 23.5 m). The inside areas of the pens were a bedded pack, and were bedded with straw once every 2 wk. Because the consumption of

Table 1. Ingredient composition of treatment diets with limit-fed control or distillers dried grains with solubles (DDG) concentrate mixes with ad libitum grass hay to growing replacement dairy heifers

	Treatment[1]	
Ingredient, % of DM	Control	DDG
Brome grass hay[2]	68.5	68.5
DDGS	0.0	30.0
Ground corn	12.0	0.0
Soybean meal	8.12	0.0
Expellers soybean meal	6.27	0.0
Soyhulls	3.65	0.0
Vitamin and mineral premix[3]	0.75	0.75
Calcium carbonate	0.38	0.38
Salt	0.38	0.38

[1]Both treatment diets were formulated with NRC (2001) to contain 13.4% CP (% of DM), 7.4% RDP, 6.0% RUP, ME of 2.35 Mcal/kg of DM, and NE_G of 0.87 Mcal/kg of DM.

[2]Predicted % of intake.

[3]Contained: 3.19 g/kg of lasalocid, 20.8% Ca, 26.7% NaCl, 1.6% Mg, 0.5% K, 880 mg/kg of Cu, 50 mg/kg of I, 25 mg/kg of Se, 3,880 mg/kg of Zn, 550,000 IU/kg of vitamin A, 110,000 IU/kg of vitamin D_3, and 4,180 IU/kg of vitamin E.