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Growth performance and total-tract nutrient digestion for Holstein heifers limit fed diets high in distillers grains with different forage particle sizes

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ABSTRACT

This study evaluated dairy heifer growth performance and total-tract nutrient digestion when fed diets high in distillers dried grains with solubles with different forage particle sizes. An 8-wk randomized complete block design study was conducted using 22 Holstein heifers (123 ± 32 d of age; BW 140 ± 23.5 kg). Treatments were 15% chopped (CHOP) or 15% pelleted (PELL) alfalfa hay on a DM basis. Both diets also contained 30% distillers dried grains with solubles, 53.8% corn silage, and 1.25% mineral mix and were limit fed for DMI at 2.3% of BW. Growth measurements were taken every 2 wk, and jugular blood samples were taken every 4 wk. During wk 8, rumen samples were taken on 2 d via esophageal tubing to evaluate fermentation, and fecal grab samples were collected at 8 times over 3 d and composited by heifer to determine total-tract nutrient digestion. Heifer DMI increased with CHOP, and BW and ADG were similar between treatments. Feed efficiency was less in the CHOP-fed heifers. Frame measurements were similar, with the exceptions of paunch girth, heart girth, and hip width, which were greater for CHOP. The CHOP-fed heifers had less BCS than PELL. Rumen fermentation characteristics were similar; however, rumen pH was greater for PELL. Serum glucose and plasma cholesterol were similar between treatments, but plasma urea nitrogen tended to be greater in heifers fed CHOP. Total-tract digestibility of nutrients was similar between treatments. Results indicate that forage particle size minimally affects utilization of distillers dried grains with solubles by heifers.

Key words: dairy heifer, growth performance, distillers dried grains with solubles, particle size

INTRODUCTION

In a meta-analysis of past research, Zanton and Heinrichs (2005) found that to reach the optimal BW at calving without any adverse effects to mammary development, heifers should be fed to meet an ADG of 0.8 kg/d. They recommended ADG and BW at calving can be accomplished through limit feeding (Zanton et al., 2007). The strategy of limit feeding uses rations greater in concentrates and lesser in forage, that are more nutrient dense diets, fed at a set intake amount to meet requirements. Heifers that are limit fed exhibit greater diet digestibility and feed efficiency, and have less nutrient excretion (Hoffman et al., 2007; Zanton and Heinrichs, 2009).

Despite increasing availability of distillers dried grains with solubles (**DDGS**), there is limited research on the effects of feeding DDGS at greater inclusions than 20% DM to growing dairy heifers (Suarez-Mena et al., 2013; Schroer et al., 2014; Anderson et al., 2015a,b). Past research indicates that feeding DDGS to dairy heifers maintained growth performance, improved feed efficiency, increased nutrient digestion, and may reduce age at onset of puberty (Anderson et al., 2009; Anderson et al., 2015a,b; Manthey et al., 2015, 2016).

Forage particle size in combination with DDGS has not been examined in detail in dairy heifers. Particle size affects rumination, passage rate, and feed intake (Jaster and Murphy, 1983). Stimulation of rumination occurs when feed particles are longer than 10 mm, such as with chopped hay (Welch and Hooper, 1988). Reduction of particle size also results in decreased retention time of feed particles in the rumen (Thomson and Beever, 1980). Thus, grinding and pelleting of forage increases particulate matter passage rate and may reduce digestion (Alwash and Thomas, 1971; Thomson and Beever, 1980). Differing particle size may also affect rumen conditions and concentrates utilization in the rumen. Thus, our objective was to determine the effect of forage particle size on growth and total-tract digestion when heifers are limit fed diets high in DDGS. We hypothesized that feeding heifers chopped alfalfa hay compared with pelleted alfalfa hay would improve growth performance and increase nutrient digestion, due to more

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rumination and increased rumen retention time of larger particles.

MATERIALS AND METHODS

Experimental Design

All animal use and experiment protocols were approved by the South Dakota State University Institutional Animal Care and Use Committee. Twenty-four Holstein heifers (123 ± 32 d of age; initial BW of 140 ± 23.5 kg) were used in an 8-wk randomized complete block design with 2 dietary treatments. Heifers were paired according to birth date and randomly assigned to treatment. Heifers were put on the study in 2 groups of 12, and the study was conducted from June 2013 to November 2013. As a group entered the research barn, they were acclimated to the barn and the feeding system for 2 wk and then fed the experimental diets for 8 wk. This 2-wk period allowed for training so that heifers became accustomed to being fed individually using the Calan gate feeding system (American Calan Inc., Northwood, NH).

Before starting treatments, heifers were fed a pretrial diet consisting of 40% (DM basis) heifer grower pellets (Hubbard Feeds Inc., Mankato, MN), 40% corn silage, and 20% chopped alfalfa hay and formulated according to the NRC (2001) to contain 16.5% CP, ME of 2.6 Mcal/kg of DM, and NE_g of 1.1 Mcal/kg of DM. The pretrial diet was fed for 1 wk to acclimate heifers to eating a TMR and high corn silage diet. Treatment diets (Table 1) included a diet consisting of 15% chopped alfalfa hay (**CHOP**) or pelleted alfalfa hay (**PELL**), and the remainder of the diets consisted of corn silage, DDGS, and a vitamin and mineral mix. Treatment diets were formulated to be isonitrogenous and isocaloric.

Table 1. Ingredients of the diets containing 15% chopped alfalfa hay (CHOP) or 15% pelleted alfalfa hay (PELL) limit fed to growing dairy heifers[1]

	Diet	
Ingredient, % of DM	**CHOP**	**PELL**
Corn silage	53.75	53.75
Distillers dried grains with solubles	30.00	30.00
Alfalfa hay, chopped	15.00	—
Alfalfa hay, pellet	—	15.00
Mineral and vitamin premix[2]	0.75	0.75
Limestone	0.30	0.30
Salt	0.20	0.20

[1]Formulated according to the NRC (2001).

[2]Contained 1.76 g/kg monensin, 3% CP, 1.0% fat, 3.0% fiber, 3.0% ADF, 13.5% Ca, 3.0% P, 18.8% NaCl, 1.1% Mg, 1.1% K, 19.2 mg/kg Se, 330,000 IU/kg vitamin A, 82,500 IU/kg vitamin D_3, and 1,980 IU/kg vitamin E (Foundation Heifer Premix R1600 Medicated, Hubbard Feeds Inc., Mankato, MN).

Animal Care and Feeding

The feeding portion of the experiment was completed at the South Dakota State University Dairy Research and Training Facility (Brookings, SD). Daily observations of heifers were conducted for any signs of physical or disease problems, and if found, treatment was administered according to normal management practices.

Heifers were housed in groups of 6 per pen with 6 Calan boxes per pen. The pens consisted of an indoor roofed area (7 m × 4 m) and an outside dirt exercise lot (7 m × 23.5 m). The indoor section of the pens was manure pack bedded with straw with new bales of straw added every 2 wk. Fresh water was provided ad libitum. Every 2 wk, bales of alfalfa hay were ground using a large vertical tub grinder (Haybuster 1130, DuraTech Industries International Inc., Jamestown, ND). Heifers were fed once daily, and individual intakes were measured at 0900 h using the Calan gate feeding system. The ration was limit-fed at 2.3% of BW (DM basis), which allowed us to target an ADG of 0.8 kg/d as recommended by Hoffman (1997) and Zanton and Heinrichs (2005). Ration amounts were adjusted every 2 wk based on individual heifer BW and DM of feed ingredients. The individual ingredients were weighed for each heifer into a large tub and hand mixed into a TMR before being offered to the heifer. Although minimal, orts were weighed and the amounts were recorded before each feeding.

Animal Measurements and Sampling

Samples of alfalfa pellets, chopped alfalfa hay, corn silage, and DDGS were collected weekly and stored at −20°C until processing and analysis. Every 2 wk throughout the study body growth measurements including BW, withers height, hip height, heart girth, paunch girth, and body length were taken on 2 consecutive days at 4 h after feeding. Height was measured using Teletape (Model 2913, Ketchum Manufacturing Inc., Brockville, ON, Canada), a modified tape measure designed for livestock. Girth was measured using a weight-by-breed dairy management tape (C06070N, Nasco, Fort Atkinson, WI). Body length was measured using the same tape as used for girth from the top point of the withers to the end of the ischium (Hoffman, 1997). Body condition scores (with 1 being emaciated and 5 being obese) were observed and recorded every 2 wk by 3 independent individuals (Wildman et al., 1982). Blood samples were taken every 4 wk from the jugular vein approximately 4 h after feeding (1300 h) into one 6-mL vacutainer tube (Becton, Dickinson, and Company, Franklin Lakes, NJ) containing sodium fluoride (NaFl) for glucose analysis (Cat. #: 367729) and two 10-mL vacutainer tubes containing potassium ethylene diamine tetra-acetic acid (K_2EDTA) for all other analyses (Cat. #: 366643). Immediately after blood collection, samples were