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Influence of feeding increasing level of dry or modified wet corn distillers grains plus solubles in whole corn grain-based finishing diets on growth performance, carcass traits, and feeding behavior in finishing cattle

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ABSTRACT

One hundred and two cross-bred steer calves (BW = 368 ± 6.6 kg) were used in a 2 × 3 factorial arrangement of treatments plus a control to determine the effect of inclusion level and form of corn distillers grains plus solubles (DGS) on finishing performance, carcass characteristics, and feeding behavior using whole corn grain-based finishing diets. The DGS were fed at 0 (control), 167, 333, and 500 g/kg of diet DM using dry (DDGS) or modified wet (MWDGS) DGS. All diets contained 100 g/kg haylage as a forage source, and were formulated to contain at least 137 g/kg CP. Individual intake and feeding behavior was measured using the Insentec system. Cattle were fed until ultrasound backfat thickness reached 10 mm. Data were analyzed using GLM of SAS; treatment means were compared using contrast statements (control vs. others, DDGS vs. MWDGS, inclusion level of DGS (linear, quadratic), and interactions between form and linear and quadratic inclusion level). There were no effects ($P > 0.05$) of dietary treatment on final BW, ADG, days on feed, dressing yield (g hot carcass weight/kg final BW), hot carcass weight, marbling score, lean yield, and lean color. Rumen pH at slaughter linearly increased ($P = 0.001$) and liver abscess score linearly decreased ($P = 0.03$) with increasing DGS inclusion. There were significant quadratic form × level interactions ($P \leq 0.03$) for time at feeder, time per visit, number of meals, meal size, and eating rate. Number of meals (meals/d) linearly increased ($P = 0.006$) with increasing DGS inclusion and was greater ($P = 0.006$) in cattle fed MWDGS than those fed DDGS. Meal size linearly decreased ($P = 0.002$) with increasing DGS inclusion and was greater ($P = 0.002$) in cattle fed DDGS than those fed MWDGS. Finishing performance and carcass traits were generally not affected by feeding DDGS or MWDGS up to 500 g/kg diet DM in whole corn grain-based finishing diets. However, liver abscess scores were reduced with DGS inclusion and feeding behavior was influenced by form and level of DGS.

1. Introduction

Distillers grains plus solubles (DGS) are a byproduct of the ethanol industry, which are formed after the

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fermentation of cereal grain by yeast (Klopfenstein et al., 2008). Corn grain is the primary feedstock used to produce ethanol fuel in North America by the dry milling process (Peter et al., 2000). Because the dry milling process converts the starch in grain to ethanol by fermentation, the other nutrients such as protein and other components (fat, fiber, P and S) become approximately 3 times more concentrated in the ethanol byproducts as compared to original grain (Klopfenstein et al., 2008).

The renewable biofuel industry has expanded over the last several years (Hill et al., 2006; Schrage et al., 1991) and the price of corn has also increased. This has increased the availability of ethanol byproducts, which are a viable alternative to feeding corn grain (Klopfenstein et al., 2008). Optimizing the use of DGS as a feedstuff is important as it has become a very common ingredient used in finishing diets in North America. When DGS is fed at moderate to high concentrations in the diet, the concentrations of N, P and S are often higher than nutrient requirements; therefore, the efficiency of nutrient utilization is decreased (Spiehs and Varel, 2009). Furthermore, the high level of S in DGS (6 to 10 g/kg DM or higher) may cause decreased dry matter intake (DMI), average daily gain (ADG), and liver Cu stores when DGS are used above 300 to 400 g/kg of diet DM (Klopfenstein et al., 2008). The drying process of DGS may reduce the feeding and nutritional value of DGS (Ham et al., 1994). The majority of studies on DGS have been conducted in cattle fed dry-rolled, high-moisture, or steam–flaked corn-based diets. In Ontario, many finishing operations utilize whole corn grain as the primary concentrate source. There are limited studies comparing the effect of MWDGS and DDGS on beef cattle fed whole-corn grain-based finishing diets. Also, there is limited information available on how feeding DGS influences feeding behavior in cattle. Therefore, the objectives of this research were to examine the effect of inclusion level of MWDGS and DDGS in whole corn-based diets on cattle growth performance, carcass characteristics, and feeding behavior.

2. Materials and methods

2.1. Animal care and experimental design

This experiment followed the recommendations of the Canadian Council on Animal Care (1993) and was approved by the University of Guelph Animal Care Committee. One hundred and two cross-bred steers predominately of Angus and Simmental breeding weighing 368 ± 6.6 kg were randomly assigned to 7 pens (1 pen per treatment) and were used in a completely randomized design with a 2×3 factorial arrangement of treatments plus a control. Dietary treatments (Table 1) consisted of control, 167 g/kg, 333 g/kg, and 500 g/kg of diet DM from dried distillers grains plus solubles (DDGS) or modified wet distillers grains plus soluble (MWDGS) replacing corn in all treatments and soybean meal and urea in the control treatment. The DDGS and MWDGS were sourced from Greenfield Ethanol Inc. and were produced in the same plant. The control treatment had 12 steers and all other treatments had 15 steers. Calves were fed diets as a total mixed diet once daily. Individual intake was determined using the Insentec (Insentec, B.V., Marknesse, the Netherlands) system. The Insentec system measures every feeding event (feed disappearance and time of even) using RFID technology and feed troughs equipped with weigh cells. All diets contained 100 g/kg haylage as a forage source and were formulated to contain at least 137 g/kg CP and to meet or exceed the estimated requirements for CP, minerals and vitamins according to NRC (1996). Calves were fed a corn silage/haylage-based diet for at least two weeks before starting the experiment to adapt to facilities and then calves were adapted to dietary treatments over the first 28 d on experiment. During the 28 d adaption period, calves were fed 250, 500, 600, and 800 g/kg of concentrate during the first, second, third and fourth week respectively. At the beginning and end of the trial, cattle were weighed twice in the morning before feeding over two consecutive days. Body weights were recorded every 28 d throughout the experiment. Average daily gains were computed by subtracting initial live weight from final BW divided by the days on feed.

2.2. Feeding behavior measurements and sample collection

Radio frequency ID tags were placed in the right ear prior to the experiment. For each pen, there were four Insentec electronic feeding stations as described by Montanholi et al. (2010) allowing for monitoring of individual feed intake and feeding behavior characteristics. Feeding behavior characteristics were defined as previously described by Montanholi et al. (2010) as follows: total daily intake (kg DM/d), time at feeder (min/d), daily visits to the feeder (events/d), time per visit (min/visit), visit size (g DM/visit), number of meals per day (events/d), time per meal (min/meal), meal size (g DM/meal), and eating rate (g DM/min), and these data are reported as the average of each individual animal over the entire experiment. Meal was defined as a distinct eating period, which may include short breaks, but which are separated by intervals of no longer than 7 min (Forbes, 1995).

2.3. Laboratory analyses

Diet samples were collected weekly and frozen at -20 °C for further analysis at the Agri-Food Laboratories Inc. (Guelph, ON, Canada). Samples were dried in a 55 °C oven for at least 48 h, ground to pass a 1-mm screen, and analyzed for DM and ash by standard procedures (AOAC, 1990). Diet *N* concentrations were determined using a Leco N analyzer (Leco Corporation, St. Joseph, MI, USA) and percent CP was calculated by multiplying *N* concentration $\times$ 6.25. Neutral detergent fiber (aNDF; assayed with heat stable amylase and sodium sulfite and expressed inclusive of residual ash) and acid detergent fiber (ADF; expressed inclusive of residual ash) concentration was determined by the method of Robertson and Van Soest (1981) using an Ankom fiber analyzer (Ankom Technology Crop., Fairport, NY, USA). Calcium and phosphorus concentrations were determined as described by AOAC (1990).