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Effects of *Leymus chinensis* replacement with whole-crop wheat hay on blood parameters, fatty acid composition, and microbiomes of Holstein bulls

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ABSTRACT

This study investigated the replacement of *Leymus chinensis* (LC) with whole-crop wheat hay (WCWH) in the diets of Holstein bulls in the fattening stage and examined the potential effects on blood parameters, fatty acids in rumen fluid and serum, and the rumen microbiomes. In this study, 12 Holstein bulls in the fattening period (body weight = 485.0 ± 40.8 kg) were assigned to 1 of 4 dietary treatments using a 4 × 4 Latin square design. Each experimental period consisted of a 17-d adaptation period and a 5-d collection period. The dietary treatments consisted of 4 proportions of WCWH (0, 33, 67, and 100%) as a substitute for LC (designated as WCWH0, WCWH33, WCWH67, and WCWH100, respectively). On d 18 and 22 of each experiment period, blood and rumen content samples were collected for analysis, respectively. Real-time quantitative PCR was used to analyze the rumen microbiomes. The results from this study revealed no differences in the saturated, monounsaturated, and polyunsaturated long-chain fatty acid proportions of rumen liquid among the treatments. It was observed in the present trial that rumen microbiotal flora were not significantly different in the bulls fed LC compared with the bulls fed WCWH. Additionally, blood sample analysis demonstrated that the concentration of urea nitrogen in the WCWH100 group was higher than that observed in the other groups. Meanwhile, no differences were detected for other serum parameters. There were no differences in the proportions of serum saturated, monounsaturated, and polyunsaturated long-chain fatty acids among the treatments. In conclusion, our data revealed that LC can be replaced with WCWH in the diet of Holstein bulls in the fattening stage with no negative effects on the blood indicators, fatty acids, and microbiomes.
Key words: Holstein bull, blood parameter, fatty acid, microbiome

INTRODUCTION

Leymus chinensis (**LC**), commonly known as Chinese wildrye, is a native, cool-season perennial species of Gramineae that is mainly distributed in the Eurasian Steppe, including the eastern Inner Mongolian Plateau and the Songnen Plain in China (Chen et al., 2013). However, regions such as North and Central China have limited LC production. Livestock farms of these regions have to buy LC and transport the LC over long distances. Therefore, in the ruminant industry, it is necessary to explore alternative roughage sources to avoid the high line-haul expenses of LC.

Wheat is cultivated as one of the principal crops, and wheat straw is a plentiful agricultural residue (Kim and Dale, 2004; Shi and Yu, 2017). However, most of the wheat straw is burned, which results in not only severe resource waste but also air pollution such as particulate matter (Li et al., 2008; Talebnia et al., 2010). Therefore, it would be greatly beneficial and significant to fully use the wheat straw residue. Applications of agronomy and plant breeding methods for the production of whole-crop wheat (**WCW**), together with its potentially lower production cost, have resulted in the increased use of this crop as feed for ruminants (Walsh et al., 2009). For ruminants, ingestion of WCW, which consists of wheat straw and wheat grain, has greater nutrient content and higher feed efficiency than ingestion of wheat straw alone. Several studies have shown that fermented WCW can increase DMI and improve rumen fermentation in beef cattle (Keady et al., 2007; Owens et al., 2009). Weinberg and Chen (2013) reported that prolonging the storage period of WCW may result in decreased digestibility values of NDF and

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DM. Furthermore, it was reported that the increased ratios of grain to straw plus chaff of WCW ensilage in the diets can abate enteric methane emission in finishing beef steers (Mc Geough et al., 2010). Therefore, replacement of whole-crop wheat hay (**WCWH**) is greatly important and urgently necessary. Not only can this switch conserve energy and reduce pollution, but it can also contribute to the combination of agriculture and animal husbandry.

Different forages may have an effect on rumen fermentation and rumen microbes (Zhu et al., 2013). Results from previous research have revealed that inclusion of 5% NaOH-treated corn straw as a substitute for wheat hay in the TMR of lactating cows had a significant effect on the bacterial community within the rumen (Jami et al., 2014). It is commonly known that fatty acid composition in the rumen is influenced by changes in dietary fatty acids via the rumen microbiome, such as increased SFA due to biohydrogenation of dietary UFA (Toral et al., 2011). Moloney et al. (2013) reported that there was no difference in the fatty acid composition of intramuscular lipids when grass silage was replaced with WCW silage in beef cattle. Furthermore, changes in diet can alter blood metabolites, including the biochemical index and fatty acid composition of blood (Szkudelska et al., 2016). A previous study had shown that a partial replacement of LC with corn stover in lactation diets did not negatively affect the blood metabolites of dairy cows (Shi et al., 2015). However, there is little published information on the effects of WCWH as an LC replacement. Therefore, we tested several blood parameters, fatty acid composition of rumen liquid and serum, and the microbiomes of Holstein bulls who were exposed to a changed diet. It could be hypothesized that WCWH may replace LC in the diets of finishing dairy bulls without having a negative effect. The objectives of the trial were to study the effects of WCWH as a substitute for LC on blood parameters, rumen fatty acid, and microbial flora in Holstein bulls.

MATERIALS AND METHODS

This study was performed in accordance with the approved Regulations for the Administration of Affairs Concerning Experimental Animals (The State Science and Technology Commission of P. R. China, 1988). The experimental procedures were approved by the Animal Welfare and Ethics Committee of China Agricultural University (permit no. DK1008).

Animals, Diets, and Experimental Procedure

The feeding experiment was conducted at the Xinzhicheng Dairy Farm (Zhuozhou City, Hebei Province, China). Approximately 15 t of WCW was reaped from nearby farmland at the milky ripe stage. The height of the wheat stubble was 10 to 15 cm. Next, the WCW was carefully dried by the sun and kept for the feeding trial. Approximately 20 t of LC was acquired from Northeast China through line haul.

Twelve Holstein bulls (BW = 485.0 ± 40.8 kg) were assigned to 1 of 4 dietary treatments using a 4 × 4 Latin square design. The experimental diets comprised 45% roughage and 55% concentrate and included 4 dietary conditions of WCWH (0, 33, 67, and 100%) as a substitute proportion of LC. All diets met NRC (2000) requirements and were designed to be isocaloric and isonitrogenous. Dietary ingredients and nutrient compositions for the trial are shown in Table 1. The nutrient compositions of LC and WCWH are shown in Table 2. Dietary fatty acid composition is presented in Table 3. Each experimental period consisted of 17 d of diet adaptation and 5 d of sample collection. Then, the bulls were vaccinated, expelled of worms, weighed, and tagged using numbered tickets before starting the experiment. Animals were offered experimental diets twice daily at 0700 and 1700 h and had access to water ad libitum. The amount of feed was adjusted every 3 to 4 d, permitting 5 to 10% residues.

Sampling

Between d 18 and 22 of each experimental period, the forage and residues were collected. All feed samples were dried at 65°C for 48 h in the oven, ground through a 1-mm screen using a Wiley mill (A. H. Thomas Co., Philadelphia, PA), and kept at −20°C until analysis for DM, OM, CP, ether extract, NDF, and ADF.

On d 18 of each experimental period, blood was obtained via the jugular vein into 10-mL evacuated serum tubes before the morning feeding. Serum samples were obtained after the tubes were centrifuged at 3,000 × g at 4°C for 20 min. Next, the serum was separated into 3 aliquots and kept at −20°C for biochemical indicators and long-chain fatty acid (**LCFA**) analysis.

Approximately 100 mL of rumen samples was collected using an esophageal tube 2 h after the morning feeding on d 22 of each experimental period. Three aliquots of 10-mL samples were taken and stored at −20°C for LCFA analysis. Three aliquots of 1-mL samples were stored in liquid nitrogen for analysis of the rumen microbiomes.

Analytical Procedures

Chemical Composition. The DM and ash of feed samples were determined according to methods 934.01 and 924.05 of AOAC (1990), respectively. The content