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Fermentation characteristics and feeding value of ensiled wet corn distillers grains in combination with wet beet pulp for lactating dairy cows

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ABSTRACT

Two experiments were conducted to evaluate (1) fermentation characteristics of ensiled wet corn distillers grains with solubles (WDG) and wet beet pulp (WBP) and (2) feeding value of ensiled blends of WDG and WBP in lactating dairy cow diets. On an as-fed basis, the ratio of ensiling for WDG:WBP was (1) 100:0 (DG100), (2) 67:33 (DG67), (3) 33:67 (DG33), and (4) 0:100 (DG0), respectively. Feedstuffs were ensiled and sampled at d 0, 4, 8, 21, and 112. Initial pH was lowest for DG100 and increased as the WBP was included. Low initial pH and increased acetic acid concentration with decreasing lactic acid concentration may have helped preserve both feedstuffs and their blends. Lactic acid was the predominant organic acid for DG100, and acetic acid was predominant at d 112 for the other 3 treatments. A feeding study followed the ensiling study. Nine cows (92 ± 4 DIM; mean ± SD) were used in a replicated 3 × 3 Latin square design. They were fed the (1) control diet; (2) low WDG diet with 21.7% DG33 blend (DM basis); and (3) high WDG diet with 24.6% DG67 blend (DM basis). There was no effect of diet on DMI. Milk yield was greater for cows fed WDG diets compared with cows fed the control diet; however, there was no effect of diet on energy-corrected milk. Milk fat concentration decreased for cows fed WDG diets compared with control diet; however, milk fat yield was not affected by diet. Cows fed WDG diets tended to produce milk with greater milk protein concentration and yield compared with cows fed the control diet, but there was no difference between WDG diets. Results provide evidence that ensiling WDG and WBP to preserve each wet by-product was possible and that ensiled blends could be incorporated in diets of lactating dairy cows to increase milk production and milk protein yield.

Key words: ensiling, fermentation, wet beet pulp, wet corn distillers grains

INTRODUCTION

Wet distillers grains with solubles (**WDG**) is used as a source of protein and energy (Birkelo et al., 2004; Anderson et al., 2006), and wet beet pulp (**WBP**) is used as an energy source (Boguhn et al., 2010) in dairy cow diets. Long-term storage of these feedstuffs can be challenging, particularly because of their high moisture content (Abrams et al., 1983; Leupp et al., 2006a,b). Ensiling is an alternative to store these feedstuffs for prolonged periods. Research has demonstrated that WDG can be ensiled alone or blended with other feeds because of its intrinsic low initial pH (Anderson et al., 2009; Mjoun et al., 2011; Anderson et al., 2015). Also, WBP can be ensiled alone or with lactic acid bacteria (Zheng et al., 2011) and with liquid or dry feed ingredients (Leupp et al., 2006a,b).

Ensiled by-products can be used as feed ingredients in dairy cattle diets. Ensiling WDG alone or in combination with corn, brome hay, corn silage, soy hulls, or corn stalks has been demonstrated to sustain heifer growth (Anderson et al., 2009; Anderson et al., 2015) or maintain milk production of dairy cows (Ramirez-Ramirez et al., 2011). Boguhn et al. (2010) demonstrated that ensiled WBP can be fed to dairy cows up to 20% of diet DM without affecting milk yield. However, there is no information on feeding ensiled blends of WDG and WBP to dairy cattle.

The WDG and WBP are complementary because WBP is low in CP, fat, P, and S (Evans and Messerschmidt, 2017), whereas these nutrients are often found in high concentration in WDG (Kalscheur et al., 2012). It was hypothesized that ensiling them together would improve preservation of the final product attributed to their intrinsic low initial pH and help dilute the high nutrient concentration in WDG with WBP, a feed that contains a lesser nutrient profile (NRC, 2001). The objectives of these 2 studies were to (1) evaluate fermentation of WDG and WBP when ensiled alone or together and (2) evaluate

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the ability of ensiled blends of WDG and WBP as feed ingredients to sustain milk production and milk composition of dairy cows.

MATERIALS AND METHODS

The 2 experiments were conducted at the Dairy Research and Training Facility of South Dakota State University, Brookings. All animal procedures used were approved by the South Dakota State University Institutional Animal Care and Use Committee.

Ensiling Study

Ensiling WDG and WBP. Corn WDG and WBP were obtained from a regional ethanol plant and a sugar plant, respectively. Individual feedstuffs and blends of the WDG and WBP, on an as-fed basis, were combined and mixed in a mixer wagon before ensiling in approximately 5.5-t batches. Feedstuffs were ensiled into 2.74-m-diameter silo bags using a Roto-Press bagger (Model 890, Sioux Automation Center Inc., Sioux Center, IA). Each type of feedstuff was ensiled in 3 individual, 2-linear-m sections of the silo bags. Treatment combinations of WDG and WBP were (1) 100:0 WDG:WBP (**DG100**), (2) 67:33 WDG:WBP (**DG67**), (3) 33:67 WDG:WBP (**DG33**), and (4) 0:100 WDG:WBP (**DG0**). The WDG:WBP ratios for DG67 and DG33 were 72:28 and 38:62 on a DM basis.

Feed Sample Collection and Chemical Analysis. Sampling of ensiled blends was done at d 0, 4, 8, 21, and 112 of ensiling from each section. Samples were collected through an opening made in the silo bag by cutting a crisscross section of approximately 20 × 20 cm. The opening was made at approximately 1 m from the ground. After removing the top-most layer of feedstuff, approximately 0.5 to 1 kg of sample was collected into a bucket by digging 30 cm into the silage. After sample collection, the excess loose material removed was repacked in the opening and the silo bag taped closed to avoid air infiltration and spoilage. At least 0.5 m of separation was maintained between successive sampling locations within each section. Samples were stored at −20°C until laboratory analysis. All samples were analyzed for DM, CP, pH, ammonia-N, lactic acid, acetic acid, propionic acid, ethanol, and water-soluble carbohydrates (**WSC**). Samples of ensiled feeds from d 112 were additionally analyzed for NDF, ADF, crude fat, ash, minerals, and OM loss. One set of samples was dried at 55°C in a forced-air oven (style V-23, Despatch Oven Co., Minneapolis, MN) for 48 h and then ground through a 2-mm screen using a Wiley Mill (model 3; Thomas Scientific, Swedesboro, NJ). Samples were further ground through a 1-mm screen using an ultracentrifuge mill (Brinkman Instruments Co., Westbury, NY) and analyzed for DM (Shreve et al., 2006), ash (AOAC International, 2006; method 942.05), CP (AOAC International, 2006; method 968.06), NDF (Van Soest et al., 1991), ADF (Robertson and Van Soest, 1981), and crude fat (AOAC International, 2006; method 920.39). Organic matter losses of the ensiled product were determined at d 112 of ensiling using ash as a marker calculated as [1 − (ash at d 0/ash at d 112)] × 100 (Garcia et al., 1989). The second set of samples were frozen and sent to Dairyland Laboratory (Arcadia, WI) to determine fermentation characteristics, including pH and concentrations of lactic acid, acetic acid, propionic acid, ethanol, ammonia-N, WSC, and minerals. Lactic acid, acetic acid, propionic acid, and ethanol were analyzed using HPLC with the method of Siegfried et al. (1984) as modified by Muck and Dickerson (1988). Ammonia-N was determined using method 920.03, Nitrogen (Ammoniacal) in Fertilizers: Magnesium Oxide Method of the AOAC procedures (AOAC International, 2006). Water-soluble carbohydrates were determined as described by Nelson (1944). Minerals (Ca, P, Mg, K, and S) were analyzed according to AOAC International (2002) procedures using an inductively coupled plasma spectrometer (Thermo Jarrell Ash, Franklin, MA).

Lactation Study

Animals, Diets, and Experimental Design. Six Holstein and 3 Brown Swiss cows averaging 92 ± 4 (mean ± SD) DIM were used to evaluate the feasibility of using both DG33 and DG67 ensiled by-products in lactating dairy cow diets. Blends of DG33 and DG67 were mixed in a TMR mixer separately on an as-fed basis and preserved in silo bags for 30 d before the feeding experiment. Cows were fed a (1) control diet with 0% DG33 or DG67 blends; (2) low WDG diet with 21.7% DG33 blend on a DM basis (**LWDG**); and (3) high WDG diet with 24.6% DG67 blend on a DM basis (**HWDG**). The WDG diets were formulated to test the ability of the ensiled WDG blends to produce milk when forage availability is limited. A portion of corn distillers dried grains with solubles and all alfalfa haylage from the control diet were replaced with the DG33 blend to formulate the LWDG diet. The HWDG diet was formulated by replacing all of the corn distillers dried grains with solubles and alfalfa haylage from the control diet. All diets were formulated to be similar in CP, NDF, ADF, and minerals and to meet or exceed requirements according to the NRC (2001).

Cows were blocked by breed and DIM and assigned to 1 of 3 experimental diets in a replicated 3 × 3 Latin square design for 3-wk feeding periods. Cows were housed in a free-stall barn and individually fed once daily (0700 h) using the Calan Broadbent feeder door system (American Calan Inc., Northwood, NH). They were given an adaptation period of 10 d before starting the study to adjust to the feeder door system. The first 2 wk of each experimental period were used for diet adaptation, and the last week of each experimental period was used for sampling and data collection. Forages used in the diets were premixed in a vertical mixer and blended with concentrates in a Calan Data Ranger (American Calan Inc.) to mix the diets as TMR. Diets were adjusted to allow for ad libitum intake

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