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Brown midrib corn shredlage in diets for high-producing dairy cows

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ABSTRACT

A novel method of harvesting whole-plant corn silage, shredlage, may increase kernel processing and physically effective fiber. Improved fiber effectiveness may be especially advantageous when feeding brown midrib (BMR) corn hybrids, which have reduced lignin content. The objective of this study was to determine the effect of feeding TMR containing BMR corn shredlage (SHRD) compared with BMR conventionally processed corn silage (KP) or KP plus chopped alfalfa hay (KPH) on intake, lactation performance, and total-tract nutrient digestibility in dairy cows. The KP was harvested using conventional rolls (2-mm gap) and the self-propelled forage harvester set at 19 mm of theoretical length of cut, whereas SHRD was harvested using novel cross-grooved rolls (2-mm gap) and the self-propelled forage harvester set at 26 mm of theoretical length of cut. Holstein cows (n = 120; 81 ± 8 d in milk at trial initiation), stratified by parity, days in milk, and milk yield, were randomly assigned to 15 pens of 8 cows each. Pens were randomly assigned to 1 of 3 treatment diets, SHRD, KP, or KPH, in a completely randomized design using a 2-wk covariate period with cows fed a common diet followed by a 14-wk treatment period with cows fed their assigned treatment diet. The TMR contained (dry matter basis) KP or SHRD forages (45%), alfalfa silage (10%), and a concentrate mixture (45%). Hay replaced 10% of KP silage in the KPH treatment TMR (dry matter basis). Milk, protein, and lactose yields were 3.4, 0.08, and 0.16 kg/d greater, respectively, for cows fed KP and SHRD than KPH. A week by treatment interaction was detected for milk yield, such that cows fed SHRD produced or tended to produce 1.5 kg/d per cow more milk, on average, than cows fed KP during 6 of the 14 treatment weeks. Component-corrected milk yields were similar among treatments. Cows fed KPH had greater milk fat concentration than cows fed KP and SHRD (3.67 vs. 3.30% on average). Consumption of dry matter, rumination activity, and sorting behavior were similar among treatments. Ruminal in situ starch digestibility was greater for SHRD than KP forages, and total-tract dietary starch digestibility was greater for SHRD than KP. Milk yield and starch digestibility were greater for SHRD than KP. Lack of improvement in milk fat content and rumination activity for SHRD compared with KP and reduced milk fat content for SHRD compared with KPH, however, suggest no improvement in physically effective fiber from the longer theoretical length of cut used with SHRD in a BMR hybrid.

Key words: corn shredlage, physically effective neutral detergent fiber, digestibility, dairy cow

INTRODUCTION

In recent years, harvesting whole-plant corn silage (**WPCS**) as shredlage (**SHRD**; Shredlage LLC, Tea, SD) has gained widespread interest among dairy producers and nutritionists. Shredlage is harvested with a commercially available self-propelled forage harvester (**SPFH**) fitted with after-market cross-grooved crop-processing rolls, and the SPFH set for a longer theoretical length of cut (**TLOC**) than commonly used.

Physically effective neutral detergent fiber (**peNDF**) can be increased in the diet by increasing the TLOC of forages (Mertens, 1997). Benefits of increased peNDF include increased rumination activity, salivary buffering, and rumen mat formation (Mertens, 1997; Zebeli et al., 2012). Milk fat yield is also related to dietary peNDF content (Mertens, 1997). Yang et al. (2001) reported that milk yield was maximized when a greater forage-to-concentrate ratio and longer forage particle size were used together. There may, however, be a limit to increasing the TLOC in forages; increasing length increases rumen bulk. Dado and Allen (1995) reported that an increase in rumen bulk has a depressing effect on the percentage of large meals consumed by dairy cattle. However, Yang and Beauchemin (2007) reported that, provided the overall dietary NDF was kept low, DMI was not affected by increased TLOC of the forage. Feed bunk sorting is another concern with increased TLOC of forages. Leonardi et al. (2005) suggested that when increasing the mean particle length of forages with greater TLOC it is important to minimize the

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proportion of particles retained on the coarsest sieves to prevent sorting.

Hybrid type may also influence the physical effectiveness of WPCS. Brown-midrib (**BMR**) WPCS generally has greater in vitro NDF digestibility (**ivNDFD**) than conventional hybrids (Ferraretto and Shaver, 2015). Therefore, BMR WPCS may not elicit the same chewing activity as conventional WPCS and, thus, is less effective as a source of peNDF (Zebeli et al., 2012). Evidence for this, however, is equivocal. Oba and Allen (2000) reported that despite increased NDF digestibility, the physical effectiveness of BMR WPCS was not compromised. In contrast, Taylor and Allen (2005) found that feeding BMR WPCS decreased rumination activity and, thus, physical effectiveness.

Potential improvements in starch digestibility appears to be an important benefit of the cross-grooved processing rolls used in the harvest of SHRD. A previous trial completed by Ferraretto and Shaver (2012) reported greater kernel-processing score for SHRD compared with conventionally processed WPCS (**KP**). An increase in total-tract dietary starch digestibility (**ttSTD**) was reported which appeared to be related to increased ruminal starch digestibility for the SHRD. Ferraretto and Shaver (2012) also reported that cows fed SHRD produced more FCM and ECM than cows fed KP WPCS, with the increase thought to be related primarily to greater kernel processing and starch digestibility (Bal et al., 2000).

The primary objective of our study was to determine the effect of feeding BMR SHRD compared BMR KP on lactation performance and starch digestibility in dairy cattle fed TMR. A secondary objective was to determine the effect of feeding BMR SHRD compared with BMR KP with added chopped alfalfa hay (**KPH**) in TMR to evaluate SHRD as a source of peNDF.

MATERIALS AND METHODS

Nineteen hectares of a BMR silage corn hybrid (F2F627; Mycogen Seeds, Dow AgroSciences LLC, Indianapolis, IN) were planted on May 8, 2013, at a density of 75,000 seeds per hectare at University of Wisconsin-Madison Agricultural Research Station (Arlington, WI). The KP and SHRD were harvested at approximately one-half milk line stage of kernel maturity on September 18, 2013, with SHRD harvested in the morning and KP harvested in the afternoon. The field was harvested in alternating strips in an attempt to maintain similar nutrient composition for the SHRD and KP treatments. A Claas 940 SPFH (Claas Jaguar, Claas of America Inc., Omaha, NE) equipped with SHRD processing rolls (Scherer Design Engineering Inc., Tea, SD) set for 26-mm TLOC, 2-mm roll gap, and 32% roll speed differential [(fast speed – slow speed)/fast speed] was used to harvest SHRD. The same SPFH equipped with a conventional Claas type 0130500.2 processor (Claas Jaguar, Claas of America Inc.) set for 19-mm TLOC, 2-mm roll gap, and 40% roll speed differential was used to harvest KP. Both SHRD and KP were inoculated with *Lactobacillus buchneri* 40788 and *Pediococcus pentosaceus* 12455 (Biotal Buchneri 500, Lallemand Animal Nutrition North America, Milwaukee, WI) at 5.0×10^5 cfu/g of forage. The silages were stored in side-by-side 3-m diameter silo bags for approximately 4.5 mo before initiation of the feeding trial on January 30, 2014.

All experimental protocols were approved by the Animal Care and Use Committee of the College of Agriculture and Life Sciences at the University of Wisconsin-Madison. One hundred twenty Holstein cows averaging 81 ± 8 DIM and 717 ± 9 kg of BW at trial initiation were stratified by parity (primi- and multiparous), DIM, and milk yield and randomly assigned to 15 pens of 8 cows each in a completely randomized design in the University of Wisconsin-Madison Emmons-Blaine freestall milking parlor dairy facility (Arlington, WI). Each balanced pen consisted of 2 primiparous and 6 multiparous cows. Pens were randomly assigned to a treatment TMR (Table 1) in a 16-wk continuous-lactation experiment that included a 2-wk covariate period in which all pens were fed a common diet (Table 1) containing the general herd nonexperimental conventional-hybrid SHRD in TMR followed by a 14-wk treatment period where pens were fed their assigned treatment TMR containing BMR WPCS. The TMR treatments contained KP, KPH, or SHRD. Treatment TMR were formulated to be isonitrogenous and trace minerals and vitamins were supplemented to meet or exceed NRC (2001) guidelines. All cows received bST (Posilac, Elanco Animal Health, Greenfield, IN) every 14 d starting on d 1 of the covariate period.

Experimental diets were mixed and fed once daily. The pens were supplied with TMR to allow for 5% refusals, with daily DMI determined on a pen basis throughout the study. Daily pen refusals were recorded each morning before new feed delivery using feeding management software (Feed Supervisor, Supervisor Systems, Dresser, WI). Daily pen DMI was measured as the difference between the as-fed feed offered and as-is feed refusals (orts) multiplied by the DM content of the TMR. Body weight on a pen basis and BCS (1 to 5 in 0.25-unit increments; Wildman et al. 1982) on an individual cow basis were recorded every 14 d starting in the second covariate week and continuing throughout the trial. Measurements of BCS were averaged by pen