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Inclusion of wheat and triticale silage in the diet of lactating dairy cows

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ABSTRACT

The objective of this experiment was to partially replace corn silage with 2 alternative forages, wheat (*Triticum aestivum*) or triticale (*X Triticosecale*) silages at 10% of the diet dry matter (DM), and investigate the effects on dairy cow productivity, nutrient utilization, enteric CH_4 emissions, and farm income over feed costs. Wheat and triticale were planted in the fall as cover crops and harvested in the spring at the boot stage. Neutral- and acid-detergent fiber and lignin concentrations were higher in the wheat and triticale silages compared with corn silage. The forages had similar ruminal in situ effective degradability of DM. Both alternative forages had 1% starch or less compared with the approximately 35% starch in corn silage. Diets with the alternative forages were fed in a replicated 3 × 3 Latin square design experiment with three 28-d periods and 12 Holstein cows. The control diet contained 44% (DM basis) corn silage. In the other 2 diets, wheat or triticale silages were included at 10% of dietary DM, replacing corn silage. Dry matter intake was not affected by diet, but both wheat and triticale silage decreased yield of milk (41.4 and 41.2 vs. 42.7 ± 5.18 kg/d) and milk components, compared with corn silage. Milk fat from cows fed the alternative forage diets contained higher concentrations of 4:0, 6:0, and 18:0 and tended to have lower concentrations of total *trans* fatty acids. Apparent total-tract digestibility of DM and organic matter was decreased in the wheat silage diet, and digestibility of neutral-and acid-detergent fiber was increased in the triticale silage diet. The wheat and triticale silage diets resulted in higher excretion of urinary urea, higher milk urea N, and lower milk N efficiency compared with the corn silage diet. Enteric CH_4 emission per kilogram of energy-corrected milk was highest in the triticale silage diet, whereas CO_2 emission was decreased by both wheat and triticale silage. This study showed that, at milk production of around 42 kg/d, wheat silage and triticale silage can partially replace corn silage DM and not affect DM intake, but milk yield may decrease slightly. For dairy farms in need of more forage, triticale or wheat double cropped with corn silage may be an appropriate cropping strategy.
Key words: dairy cow, forage, triticale silage, wheat silage

INTRODUCTION

Dairies in the northeastern United States typically grow their own forages. The most used forage, corn silage, leaves bare soil after fall harvesting until spring planting. Cover crops, such as small grains and clovers, have been used to prevent soil erosion during bare soil periods. Preserving the soil is critically important for continued crop productivity, and therefore has long-term benefits. Cover crops have the potential to efficiently use fall-applied manure and reduce nitrate leaching (Shepherd, 1999; Di and Cameron, 2002; Carey et al., 2016); however, planting a cover crop requires a short-term investment of labor, equipment, and other inputs. The use of cover crops as an alternative forage has increased in popularity as a way to offset planting costs, increase the annual forage yield per acre, and thereby harvest more forage from the same land base. Recent plot studies conducted at The Pennsylvania State University showed a 4.5 to 6.5 t of DM/ha average annual forage yield increase when double cropping corn silage with rye or triticale cover crop harvested as silage in the flag leaf stage (G. W. Roth, The Pennsylvania State University, University Park, PA, personal communication). However, the corn silage portion of annual forage yields typically decrease between 10 and 20%, depending on planting date, under double-cropping management due to delayed planting (PSU, 2015). Less corn silage inventory leads to the question: Can cover crop silages replace a portion of corn silage in dairy cattle diets? Several studies in the United Kingdom have reported similar milk yield (**MY**) responses to corn or wheat silages harvested after kernel development (Hameleers, 1998; Sinclair et al., 2005). In those studies, however, the wheat silage contained higher starch concentrations than the corn silage. In Canada, Khorasani et al. (1993) compared

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cereal grain silages, including triticale, to alfalfa haylage; they reported a decrease in DMI for triticale silage but no significant difference in MY, and suggested that triticale silage could be used in dairy cow rations. The dough stage harvest schedule increases starch content but delays harvest past the planting window for corn in the northeast United States, and, as such, cannot be used with corn silage double cropping. Harvesting cereal crops at the boot stage yields similar NDF content to the dough stage (Khorasani et al., 1997), but with increased NDF digestibility (Arieli and Adin, 1994). Additionally, at the flag leaf or boot stages, cereal crops can have CP concentrations above 12% (Fearon et al., 1990; Ashbell et al., 1997; Crovetto et al., 1998). Wheat and triticale are 2 cereal grain cover crops suited to the northeast United States that are used as lactating dairy cow forage in other areas of the world. Furthermore, both forages grow well in cool weather and survive cold winters.

Therefore, we hypothesized that both wheat and triticale, when harvested in the boot stage, could serve as alternative forages to augment corn silage use in lactating dairy cow rations in the northeastern United States. The objective of the experiment was to replace corn silage with either triticale silage or wheat silage at 10% of the diet DM and investigate the effects on DMI, MY, milk components and fatty acid (**FA**) profile, nutrient digestibility, N utilization, enteric CH_4 emissions, and income over feed costs (**IOFC**) in lactating dairy cows.

MATERIALS AND METHODS

Crops and Silages

Wheat (*Triticum aestivum* L. 'Malabar'; King's Agriseeds, Ronks, PA) and triticale (*X Triticosecale* L. 'Hyoctane'; Seedway, Hall, NY) were grown in Centre County, Pennsylvania, at approximately 40°N latitude on Hagerstown and Hublersburg soils during the fall of 2014. Both crops were planted with a no-till drill (John Deere 1590, Moline, IL) into fields fertilized with 44.8 t/ha of dairy manure before planting, contributing 42 kg/ha of ammonium N. Forages were planted next to each other in the same field with 19-cm row spacing on October 10, 2014, after wheat harvested for grain. Seeding rate was 151 kg/ha for triticale and wheat. On April 4, 2015, both wheat and triticale were fertilized with 67 kg of N/ha from a 30% urea and ammonium nitrate liquid fertilizer. A John Deere 946 mower with a roll conditioner was used to mow both crops and, after wilting to target 30% DM, the forages were gathered and chopped using a John Deere 6750 harvester. Mowing was conducted on May 13 and 19, 2015, at the boot stage for triticale and wheat, respectively, and chopping occurred on May 15 and 20, respectively. Chop length was set to 12 mm. Both crops were ensiled without inoculant in 3-m diameter plastic silage bags (Up North Plastics, Cottage Grove, MN). The corn silage, which was the control in this experiment, was a mixture of hybrids, including Mycogen TMF2R737 (112-d relative maturity; Mycogen, San Diego, CA), Dekalb DKC 52–61 (102-d relative maturity; DeKalb, St. Louis, MO), and NK N60F-3111 (107-d relative maturity; Syngenta, Basel, Switzerland). Corn silage was grown in Centre County, Pennsylvania, at approximately 40°N latitude on Hagerstown and Hublersburg soils and planted between May 1 and May 10, 2014, at a rate of 79,000 seeds/ha. It was planted with a no-till drill (John Deere 1590) into fields fertilized with 45 t/ha of dairy manure before planting contributing 42 kg/ha of ammonium N. An additional 43 kg/ha of N was applied as 30% urea and ammonium nitrate liquid before planting, and 67 kg/ha of N in the same form as a side-dress application. Corn silage harvest was conducted between September 15 and 30, 2014, at a target DM of 38% with a 19-mm chop length; corn silage was ensiled in an upright concrete silo.

Animals and Diets

All animals were cared for according to procedures approved by The Pennsylvania State University's Institutional Animal Care and Use Committee. Twelve mid-lactation Holstein dairy cows (MY = 42 ± 10.1 kg; 2.5 ± 1.38 lactations; DIM = 38 ± 5.7; BW = 632 ± 101.6 kg at the beginning of the experiment) were used in a replicated 3 × 3 Latin square design balanced for residual effects. The experiment had 3 periods and each period was 28 d, with 18 d for adaptation to the diet and 10 d for data and sample collection. Cows were allocated to 4 groups of 3 cows each based on DIM, MY, and parity. Cows within a group were randomly assigned to 1 of 3 diets, as described below. All cows were housed in the tiestall barn of The Pennsylvania State University's Dairy Research and Teaching Center (University Park). Diets were mixed and fed from a Rissler model 1050 TMR mixer (I.H. Rissler Mfg. LLC, Mohnton, PA). Cows were fed once daily around 0800 h to yield approximately 5 to 10% refusals. Feed was pushed up 3 times throughout the day. The cows were milked twice daily at 0700 and 1800 h.

Three different diets (Table 1), were fed to the cows during the experiment: a control diet (**CS**), based on corn silage and alfalfa haylage; a triticale silage diet (**TS**), triticale silage included at 10% of dietary DM, replacing 22.7% of the control diet corn silage DM; and a wheat silage diet (**WS**), wheat silage included at 10% of dietary DM, replacing 22.7% of the control diet corn