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Replacing corn silage with different forage millet silage cultivars: Effects on milk yield, nutrient digestion, and ruminal fermentation of lactating dairy cows

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ABSTRACT

This study investigated the effects of dietary replacement of corn silage (CS) with 2 cultivars of forage millet silages [i.e., regular millet (RM) and sweet millet (SM)] on milk production, apparent total-tract digestibility, and ruminal fermentation characteristics of dairy cows. Fifteen lactating Holstein cows were used in a replicated 3 × 3 Latin square experiment and fed (ad libitum) a high-forage total mixed ration (68:32 forage:concentrate ratio). Dietary treatments included CS (control), RM, and SM diets. Experimental silages constituted 37% of each diet DM. Three ruminally fistulated cows were used to determine the effect of dietary treatments on ruminal fermentation and total-tract nutrient utilization. Relative to CS, RM and SM silages contained 36% more crude protein, 66% more neutral detergent fiber (NDF), and 88% more acid detergent fiber. Cows fed CS consumed more dry matter (DM; 24.4 vs. 22.7 kg/d) and starch (5.7 vs. 3.7 kg/d), but less NDF (7.9 vs. 8.7 kg/d) than cows fed RM or SM. However, DM, starch and NDF intakes were not different between forage millet silage types. Feeding RM relative to CS reduced milk yield (32.7 vs. 35.2 kg/d), energy-corrected milk (35.8 vs. 38.0 kg/d) and SCM (32.7 vs. 35.3 kg/d). However, cows fed SM had similar milk, energy-corrected milk, and solids-corrected milk yields than cows fed CS or RM. Milk efficiency was not affected by dietary treatments. Milk protein concentration was greatest for cows fed CS, intermediate for cows fed SM, and lowest for cows fed RM. Milk concentration of solids-not-fat was lesser, whereas milk urea nitrogen was greater for cows fed RM than for those fed CS. However, millet silage type had no effect on milk solids-not-fat and milk urea nitrogen levels. Concentrations of milk fat, lactose and total solids were not affected by silage type. Ruminal pH and ruminal NH_3-N were greater for cows fed RM and SM than for cows fed CS. Total-tract digestibility of DM (average = 67.9%), NDF (average = 53.9%), crude protein (average = 63.3%), and gross energy (average = 67.9%) were not influenced by dietary treatments. It was concluded that cows fed CS performed better than those fed RM or SM likely due to the higher starch and lower NDF intakes. However, no major differences were noted between the 2 forage millet silage cultivars.
Key words: corn silage, forage millet silage, dairy cow, milk yield

INTRODUCTION

Corn silage (**CS**) is a preferential and abundantly used forage in dairy cow nutrition, principally due to its high DM yield, single-cut harvest at optimum DM contents, high NE_L concentration, capacity to sustain high milk yields, and good ensiling characteristics. However, in many temperate regions of Canada, the production of CS is risky and low-yielding, despite the use of short-season cultivars. Indeed, the growing season with warm temperatures (above 15°C) is only between 70 and 90 d. Moreover, the high N fertilizer application rate that CS necessitates makes it uneconomical for cold regions. Alfalfa and perennial grasses are the most commonly used forages on such dairy farms. But, dairy producers are often challenged with on-farm forage shortages, especially during conditions of alfalfa winter kill. Therefore, we hypothesize that forage pearl millet may be used as an emergency forage or routinely as a new forage option by dairy producers located in temperate regions.

Pearl millet [*Pennisetum glaucum* (L.) R.] is an annual semi-arid tropical grass with high biomass yield and low N fertilizer requirement, and is drought resistant and adaptable to low soil pH (Maiti and Wesche-Ebeling, 1997). Because of its adaptability to harsh conditions, millet can be grown in areas unfavorable to other cereals, such as corn (Hanna, 1995). Data regarding the feeding value of pearl millet silage to lactating cows are

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limited. Moreover, from the few published studies that have investigated the nutritive values of pearl millet, findings are highly inconsistent. For example, pearl millet (harvested after 66 d of growth; 23% DM) silage fed to lactating cows in place of alfalfa silage plus CS had no effect on milk yield or milk fat concentration, but reduced DMI and milk protein levels (Messman et al., 1992). Kochapakdee et al. (2002) have shown reduced milk production and milk protein levels when cows were fed diets containing pearl millet silage (30% DM) compared with temperate CS. In contrast, feeding pearl millet (harvested at 80 d of growth; 27% DM) silage relative to CS had similar effects on feed intake, milk yield, and milk efficiency (Amer and Mustafa, 2010).

Pearl millet is mostly grown to grain in many African and Asian countries. However, unlike grain millet cultivars, forage pearl millet offer flexible harvest dates. Indeed, forage pearl millet may be harvested from vegetative (i.e., 24% DM) to more mature (32% DM) stages, thus making it extremely suitable for the cold regions. In this study, we were also interested in testing forage pearl millet cultivars containing high levels of water-soluble carbohydrates (**WSC**). High WSC is reported to improve ensilability of forages by accelerating lactic acid production (Adesogan et al., 2004). Therefore, the objectives of this study were to determine the effects of replacing CS with 2 different forage millet silage cultivars [i.e., regular millet (**RM**) and sweet millet (**SM**)] on milk yield, milk composition, apparent total-tract nutrient digestibility, and ruminal fermentation characteristics of lactating dairy cows.

MATERIALS AND METHODS

This study was conducted at the MacDonald Campus Farm of McGill University (Sainte-Anne-de-Bellevue, QC, Canada; 45°N, 73°W). All animal procedures were conducted under approval of the Animal Care Committee of the Faculty of Agriculture and Environmental Sciences of McGill University.

Silage Preparation

Two forage pearl millet hybrids, namely RM and SM, were seeded on June 1, 2012, and harvested on July 24, 2012, at the vegetative stage and approximately 1.65 m high. Millet seeds were provided by Bélisle Solution Nutrition Inc. (Saint-Mathias-sur-Richelieu, QC, Canada). Prior to millet seeding, 100 kg of urea N/ha (46% N) was evenly applied to each field. Millet (70% moisture) was chopped into at least 12-mm particle size using a New Holland forage harvester (model 900; New Holland, New Holland, PA) and ensiled under high pressure into 45-m-long horizontal Ag-Bag silos (2.1-m diameter and approximately 50 t each; Ag-Bag, Miller-St. Nazianz Inc., St. Nazianz, WI) for approximately 2 mo. The initial WSC content of fresh RM and SM were 74 ± 7.46 and 80 ± 0.77, g/kg, respectively. The compositions of experimental silages are given in Table 1.

Animals, Experimental Design, and Diets

Fifteen multiparous Holstein cows in early to mid lactation [milk yield: 39.9 ± 5.60 kg; DIM: 75.2 ± 54.51 d; BW: 660.2 ± 77.41 kg (average ± SD)] were used in a replicated 3 × 3 Latin square experiment with 21-d periods (14 d of diet adaptation and 7 d of data collection). Cows were housed in individual tie-stalls and had free access to water. Five cows were allotted to each treatment and blocked into 5 groups of 3 by parity, milk yield, and DIM.

Three high forage isonitrogenous diets (68:32 forage:concentrate ratio) were formulated to meet nutrient requirements of lactating dairy cows in early lactation (NRC, 2001; Table 2). Experimental treatments were the replacement of CS with RM or SM silages. In all diets, the silage portion consisted of 70% CS, RM, or SM, and the remaining 30% consisted of alfalfa silage. For the objectives of this study, the proportions of experimental silages were kept constant in all dietary treatments (Table 2). Diets were offered as a TMR once daily in the morning (0800 h) for ad libitum intake. Orts were measured daily to determine daily feed intake per cow. Total mixed rations and silages were sampled daily during the data-collection periods (d 15–21 of each period) and composited by period.

In Situ Ruminal Nutrient Degradabilities of Experimental Silages

One representative sample each of CS, RM, and SM silages was obtained by mixing 200 g of the dried (65°C for 48 h) silages from each of the 3 periods. A 5-g subsample of each mixture was then placed into nylon bags (20 × 10 cm, 50-μL pore size; Ankom Technology Corp., Macedon, NY) and incubated in the rumens of 3 lactating cows (1 bag per treatment per time period per cow) fed a single type of ration and fitted with rumen cannulas for 0, 3, 6, 12, 24, 48, 72, and 96 h. At the end of each incubation time, bags were removed from the rumens and manually washed under cold tap water until the water was clear. The 0-h incubation was determined by washing the bags containing the samples. The washed bags were then dried in a forced-air oven at 65°C for 48 h. In situ residues were analyzed for DM and NDF (Van Soest et al., 1991). Data of ruminal DM and NDF disappearances were used to determine