J. Dairy Sci. 101:1–8
https://doi.org/10.3168/jds.2017-13880

Effects of homolactic bacterial inoculant on the performance of lactating dairy cows

J. L. P. Daniel,*† O. C. M. Queiroz,* K. G. Arriola,* R. Daetz,* F. Basso,‡ J. J. Romero,§ and A. T. Adesogan*[1]
*Department of Animal Sciences, Institute of Food and Agricultural Sciences, University of Florida, Gainesville 32611
†Department of Animal Science, State University of Maringá, Maringá, Brazil, 87020900
‡Department of Animal Sciences, The São Paulo State University, Jaboticabal, Brazil, 14884900
§Animal and Veterinary Sciences Program, School of Food and Agriculture, University of Maine, Orono 04469

ABSTRACT

The objective of this experiment was to determine the effect of applying a homofermentative bacterial inoculant to corn silage on the performance of dairy cows. After harvesting, corn forage was treated with nothing (CON) or with an inoculant containing a mixture of *Lactococcus lactis*, *Lactobacillus plantarum*, and *Enterococcus faecium* at 1.5×10^5 cfu/g of fresh forage (MC; SiloSolve MC, Chr. Hansen A/S, Hørsholm, Denmark). After 186 d of storage in Ag-Bags (A Miller-St. Nazianz Inc., St. Nazianz, WI), silages were fed as part of a total mixed ration containing 55% concentrates, 10% alfalfa hay, and 35% CON or MC corn silage. Sixty early-lactation Holstein dairy cows (30 multiparous and 30 primiparous) housed in a freestall barn with Calan gates (American Calan Inc., Northwood, NH) were assigned to the dietary treatments from 20 to 100 d in milk. Silage inoculated with MC had a more homofermentative pattern evidenced by greater lactic acid concentration (3.83 vs. 4.48% of DM) and lower concentrations of acetic (2.34 vs. 1.68% of DM) and propionic (0.37 vs. 0.10% of DM) acids and ammonia (9.11 vs. 7.82% of N) for CON and MC, respectively. Dry matter intake (23.1 vs. 23.2 kg/d) did not differ among treatments, but the MC silage had greater apparent digestibility of DM (68.8 vs. 70.8%), which led to greater yields of milk (37.7 vs. 38.5 kg/d), fat-corrected milk (37.6 vs. 38.4 kg/d), milk fat (1.30 vs. 1.33 kg/d), and lactose (1.83 vs. 1.92 kg/d) for CON and MC cows, respectively. Milk from cows fed MC silage had higher lactose (4.86 vs. 4.93%), lower protein (2.93 vs. 2.83%), and similar contents of fat (3.47 vs. 3.44%) compared with CON cows. Feed efficiency (fat-corrected milk/dry matter intake) was not affected by treatment (1.69 vs. 1.72 for CON and MC, respectively). Inoculation of corn silage with the homofermentative inoculant increased digestibility of the total mixed ration and increased milk yield by lactating dairy cows.
Key words: corn silage, homolactic silage inoculant, milk yield

INTRODUCTION

Lactic acid bacteria (**LAB**) have been used as inoculants to improve silage fermentation and aerobic stability. Beyond their effects on silage conservation, LAB that survive in the gastrointestinal tract of ruminants may exert probiotic effects (Weinberg et al., 2003; Han et al., 2014) and thereby potentially enhance animal performance (Weinberg et al., 2004).

Although the effects of LAB inoculation on animal performance are not consistent, previous studies have reported beneficial effects of LAB in rumen fluid such as increased microbial biomass yield (Contreras-Govea et al., 2011; Basso et al., 2014) and lower methane production (Muck et al., 2007; Cao et al., 2010). In addition, inoculation of silage with LAB has increased DM digestibility both in vitro (Weinberg et al., 2007; Cao et al., 2011) and in vivo (Kung et al., 2003; Ando et al., 2006). Recently, we conducted a meta-analysis on the effects of homofermentative and facultative heterofermentative LAB on the performance of dairy cows (Oliveira et al., 2017). Silages inoculated with at least 10^5 cfu of LAB/g of fresh forage increased milk yield by 0.37 kg/d and tended to increase DMI and milk fat and protein concentrations; therefore, inoculating corn silage with homofermentative LAB may be an effective strategy to improve the performance of lactating dairy cows. However, the meta-analysis showed that most (67%) of the studies involved inoculation of silage with only *Lactobacillus plantarum* and that relatively fewer studies involved other single bacteria or mixtures of LAB. Such mixtures typically include *Lb. plantarum* and bacteria such as *Enterococcus faecium* or *Pediococcus pentosaceus*. The latter 2 bacteria cause a faster initiation of the pH decline than *Lb. plantarum* because they are more dominant and effective at fermenting

Received September 22, 2017.
Accepted January 9, 2018.
[1]Corresponding author: adesogan@ufl.edu

plant sugars when the prevailing pH is above 5 during the early stages of fermentation (McDonald et al., 1991). Consequently, combinations of homofermentative bacteria can result in more efficient fermentations with less DM losses (Lindgren et al., 1985) and potentially improve nutrient intake and utilization. Thus, more research is needed on effects of such combinations of bacteria on milk production by lactating dairy cows.

The objective of this experiment was to determine the effect of applying a homofermentative bacterial inoculant to corn silage on the performance of dairy cows fed the corn silage as part of a TMR. We hypothesized that application of the homofermentative inoculant would improve the performance of dairy cows in early lactation.

MATERIALS AND METHODS

Silage Production

Pioneer 31P42 corn hybrid (Dupont Pioneer, Des Moines, IA) was harvested at approximately 35% DM with a forage harvester (Claas Jaguar 980, Claas of America LLC., Columbus, IN) adjusted to a theoretical length of cut of 19 mm and a roll clearance of 2 mm. At harvest, fresh chopped forage was sampled and analyzed for major nutrients and LAB counts using the same procedures described below for silage samples. The corn crop contained (DM basis) 8.05% CP, 43.4% NDF, 26.0% ADF, 3.05% ether extract, 3.26% ash, 42.2% NFC, and 6.10 log cfu of LAB/g of fresh forage.

Harvested forage was treated with nothing (**CON**) or with an inoculant containing a mixture of *Lactococcus lactis* SR 3.54, *Lb. plantarum* CH6072, and *E. faecium* M74 at 1.5 × 10^5 cfu/g of fresh forage (**MC**; SiloSolve MC, Chr. Hansen A/S, Hørsholm, Denmark). Forage from the respective treatments was packed into 2 replicate 3.66-m-wide Ag-Bags (A Miller-St. Nazianz Inc., St Nazianz, WI) with a Versa 1012 bagger (Versa Corp., Astoria, OR) and stored for 186 d before the lactation trial. To ensure that similar forage was used for each treatment, the corn field was divided into blocks; the forage from the first windrow in each block was packed into the first replicate control bag, and forage from the second windrow was packed into the first replicate MC bag. Forage from subsequent windrows was successively packed using a similar sequence into the respective bags for each treatment.

Cows and Sampling

All experimental cows were managed according to the guidelines approved by the University of Florida Institute of Food and Agricultural Sciences Animal Research Committee. Sixty lactating Holstein cows (30 multiparous and 30 primiparous) were housed in a freestall barn with sand-bedded stalls and randomly assigned at 10 DIM to a feeding gate (Calan Broadbent Feeding System, American Calan Inc., Northwood, NH) to allow measurement of individual feed intake. The experimental pens were equipped with 2 rows of fans (1 fan/6 linear meters), one row facing the feed lane immediately above the feedbunk and the other immediately above the beds. Fans were activated once ambient temperature reached 21.1°C.

During the pretreatment period (10–20 DIM), cows were fed the same diet containing half of the corn silage from each treatment. At 20 DIM, weekly cohorts were blocked by parity (primiparous and multiparous) and milk yield and, within each block, randomly assigned to 1 of the 2 treatments (CON or MC) and then enrolled in the trial. The cohorts were assigned to the trial from April 2 to September 4, 2012, over the spring and summer months. Experimental diets were compared for 80 d from 20 to 100 DIM. Cows were weighed on 2 consecutive days immediately after the morning milking at the beginning and end of the trial. Average BW was used to calculate the maintenance energy requirement (Mcal/d) as 0.08 × $BW^{0.75}$ (NRC, 2001).

Diets were formulated to meet the nutrient requirements of dairy cows producing 40 kg of milk (NRC, 2001). Diets contained 55% concentrates, 10% alfalfa hay, and 35% CON or MC corn silage, fed as a TMR twice daily, at 0800 (after the morning milking) and 1230 h. Refusals were weighed once daily at 0700 h, and the amounts were used to ensure that 105% of the previous day's feed intake for each cow was offered. Once weekly, individual ingredients and the TMR were sampled, dried at 60°C, and stored under refrigeration (5°C) for later analyses as monthly composites. Fresh samples of silages were also frozen (−20°C) for later analyses of fermentation end products. Aerobic stability tests were performed every month as described by Queiroz et al. (2013). Briefly, 2 kg of silage was placed in an open-top polystyrene box and exposed to air for 14 d. Aerobic stability was denoted as the length of time that elapsed before silage and ambient temperatures differed by more than 2°C.

Cows were milked twice daily at 0730 and 1900 h, and individual milk samples were collected once weekly from consecutive morning and afternoon milkings. Samples were analyzed by Southeast Dairy Laboratories (Belleview, FL) for fat, protein, lactose, MUN, and SCC using a Bentley 2000 near-infrared reflectance spectrophotometer (Bentley Instruments Inc., Chaska, MN). Final concentrations of milk components were