J. Dairy Sci. 99:1–8
http://dx.doi.org/10.3168/jds.2016-11238

Effects of maturity at ensiling of bermudagrass and fibrolytic enzyme application on the performance of early-lactation dairy cows

J. L. P. Daniel,*† O. C. M. Queiroz,* K. G. Arriola,* C. R. Staples,* J. J. Romero,*‡ J. H. Shin,* J. R. Paschoaloto,* L. G. Nussio,§ 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
‡Animal and Veterinary Sciences Program, School of Food and Agriculture, University of Maine, Orono 04469-5763
§Department of Animal Science, University of São Paulo, Luiz de Queiroz College of Agriculture, Piracicaba, Brazil, 13418900

ABSTRACT

The objective of this study was to examine effects of adding fibrolytic enzymes to diets containing bermudagrass ensiled after 4 or 7 wk of regrowth on the diet digestibility, ruminal fermentation and performance of lactating cows, and the interaction of the treatments. In experiment 1, 64 Holstein cows (22 ± 4 d in milk) were assigned to an experiment with a 2 × 2 factorial treatment arrangement and a 56-d duration. Treatments were diets containing 4 or 7 wk regrowth bermudagrass silage without or with an exogenous fibrolytic enzyme cocktail. The cellulase-xylanase enzyme was applied at 2.33 g/kg of total mixed ration dry matter (DM) during mixing immediately before feeding. Experiment 2 was aimed at examining treatment effects on the ruminal fermentation profile. Four ruminally cannulated cows were assigned to the 4 treatments using a 4 × 4 Latin square design with 14-d periods. No enzyme by maturity interaction was detected for any measurement. Regardless of forage maturity, applying the fibrolytic enzyme did not affect DM intake, milk yield, apparent digestibility, feed efficiency, energy balance, and ruminal fermentation though it tended to increase milk lactose concentration (4.88 vs. 4.81%). Feeding the 4-wk diet instead of the 7-wk diet increased DM intake (22.4 vs. 21.3 kg/d), digestibility of DM, neutral detergent fiber, and acid detergent fiber, and tended to increase 3.5%-fat corrected milk yield (47.2 vs. 44.3 kg/d) and milk fat yield (1.88 vs. 1.73 kg/d). Therefore, daily intake of net energy and secretion of milk energy were greater for the 4-wk diet. In addition, the 4-wk diet increased the ruminal concentrations of acetate, propionate, valerate, lactate, and total volatile fatty acids, and decreased ruminal pH, without affecting the acetate:propionate ratio. Feeding fibrolytic enzymes did not improve the performance of early-lactation dairy cows, but harvesting the forage earlier tended to improve milk production.
Key words: bermudagrass, cellulase, fibrolytic enzyme, xylanase

INTRODUCTION

Bermudagrass silage is an important source of digestible fiber in dairy cow rations in the southeast United States and some tropical countries. Although Tifton 85 bermudagrass is more digestible than other warm season grasses, its digestibility is lower than those of corn or alfalfa silage or most nonforage fiber sources used in dairy nutrition in the United States. Therefore, strategies that improve the digestion and utilization of bermudagrass silage could potentially increase the performance of dairy cows in the southeast United States and tropical/subtropical climates.

Although the literature on the subject is equivocal, several experiments have shown the potential of exogenous fibrolytic enzymes to improve nutrient utilization in ruminants (Beauchemin et al., 2003; Adesogan et al., 2014), including lactating dairy cows (Lewis et al., 1999; Kung et al., 2000; Yang et al., 2000; Arriola et al., 2011; Romero et al., 2016). Such fibrolytic enzymes often increase DMI or fiber digestibility; therefore, they are most likely to increase the performance of dairy cows in negative energy balance in early lactation (Schingoethe et al., 1999; Knowlton et al., 2002). Recently, we reported that addition of 2 fibrolytic enzyme cocktails to a diet containing 10% of bermudagrass silage tended to increase FCM and milk fat yield in cows in early lactation (Romero et al., 2016).

An important strategy to increase the digestibility of bermudagrass is harvesting the forage when it is not mature. Harvesting earlier regrowths of bermudagrass (e.g., 3 to 4 wk) instead of late regrowths (e.g., 7 to 8 wk) reduces forage production per harvest (e.g., 2.8 vs. 5.8 t of DM/ha per harvest; Mandebvu et al., 1999),

Received March 29, 2016.
Accepted July 26, 2016.
[1]Corresponding author: adesogan@ufl.edu

but usually increases digestibility and CP concentration and could potentially improve milk yield in lactating dairy cows (Chambliss et al., 1999; Mandebvu et al., 1999). To our knowledge, no study has examined if the potential benefits of applying exogenous fibrolytic enzymes to diets and harvesting the dietary bermudagrass early would result in synergistic increases in the digestibility of the diet and the performance of lactating dairy cows.

The objective was to examine the effects of adding a fibrolytic enzyme cocktail to diets containing 4 or 7 wk regrowth bermudagrass silage on the performance of dairy cows in early lactation. We hypothesized that application of the enzyme and feeding the less mature forage would synergistically increase the DMI, DM digestibility, and performance of lactating dairy cows. In addition, we hypothesized that the greatest increases in DMI, DM digestibility, and milk production would occur when the enzyme is applied to the less mature bermudagrass silage.

MATERIALS AND METHODS

Experiment 1: Treatments, Cows, and Sampling

Tifton 85-bermudagrass was grown at the Dairy Unit, University of Florida and fertilized with 415 kg/ha of N and 162 kg/ha of K_2O per year. The field was staged by mowing to a 5-cm stubble 7 wk before the anticipated harvest date. Three weeks later, the forage on half of the field assigned to the 4-wk regrowth treatment was mowed, harvested and fed to nonexperimental cows. Seven weeks after staging, the 4- and 7-wk regrowth forage in each half of the field was mowed at a DM concentration of approximately 25% on the same morning, wilted for about 2 h to a DM concentration of approximately 40%, chopped (5-cm theoretical length of cut), and ensiled without additive or inoculant treatment in 3-m-wide farm-scale silos. After 64 d of ensiling, the bermudagrass silages (Table 1) were fed with corn silage and concentrates. The TMR were formulated to be isonitrogenous and to have similar ADF and NDF concentrations (Table 2).

Care of animals used in this study followed protocols approved by the University of Florida Institute of Agricultural Science Animal Research Committee. Sixty-four lactating Holstein cows (24 multiparous and 40 primiparous) were housed in a free-stall barn when they were 10 DIM and trained to receive a common TMR in feedbunks with Calan gates (American Calan Inc., Northwood, NH) for 11 d. During the training period, the TMR contained 11.25% of 4-wk bermudagrass silage, 11.25% of 7-wk bermudagrass silage, 22.5% of corn silage, and 50% of concentrates (DM basis). From 18 to 21 DIM, DMI and milk yield and composition were measured and used as covariates in the statistical analysis.

Cows were stratified based on parity and milk yield during the previous lactation (for multiparous cows)

Table 1. Chemical composition (mean ± SD) of bermudagrass silages harvested after 4 or 7 wk of regrowth (% DM, otherwise stated)

Item	4 wk	7 wk
DM, % as fed	46.38 ± 4.97	49.75 ± 2.48
CP	18.35 ± 0.44	12.48 ± 0.57
NDF	70.38 ± 0.39	74.90 ± 0.31
ADF	40.65 ± 0.70	44.32 ± 0.68
Hemicellulose[1]	29.73 ± 0.89	30.58 ± 0.87
Ether extract	2.35 ± 0.39	2.41 ± 0.32
Ash	6.92 ± 0.28	6.12 ± 0.30
pH	4.73 ± 0.15	4.88 ± 0.20
Lactic acid	1.98 ± 0.54	1.46 ± 0.28
Acetic acid	2.02 ± 0.70	1.10 ± 0.34
Propionic acid	0.14 ± 0.12	0.19 ± 0.10
Isobutyric acid + 2,3-butanediol[2]	2.05 ± 0.47	1.39 ± 0.44
Butyric acid	0.007 ± 0.012	0.006 ± 0.011
Isovaleric acid	0.60 ± 0.17	0.31 ± 0.06
Valeric acid	0.010 ± 0.001	0.009 ± 0.001

[1]Hemicellulose = NDF – ADF.

[2]Isobutyric acid and 2,3-butanediol coeluted on the chromatogram.

Table 2. Ingredients and chemical composition of the experimental diets (% of DM)

Item	4 wk	7 wk
Ingredient		
Bermudagrass silage 4 wk	22.50	—
Bermudagrass silage 7 wk	—	22.50
Corn silage	22.50	22.50
Dry ground corn	25.00	25.00
Citrus pulp	9.14	7.08
Peanut meal	4.17	4.17
Soybean meal	5.08	8.12
Soyplus	3.13	3.13
Whole cottonseed	5.15	4.17
Mineral-vitamin mix[1]	3.33	3.33
Nutrient		
DM	55.94 ± 1.81	57.01 ± 1.46
CP	16.90 ± 0.09	16.82 ± 0.12
RDP[2]	10.76 ± 0.09	10.61 ± 0.09
NDF	34.32 ± 0.18	35.09 ± 0.49
Forage NDF	25.04 ± 0.18	26.62 ± 0.49
ADF	19.08 ± 0.14	19.68 ± 0.13
Hemicellulose[3]	15.24 ± 0.28	15.41 ± 0.65
Ether extract	4.37 ± 0.06	3.80 ± 0.05
Ash	6.75 ± 0.08	6.64 ± 0.09
NFC[4]	37.66 ± 0.35	37.65 ± 0.50

[1]Composition (DM basis): 6.35% Ca, 1.25% P, 3.99% Mg, 0.07% K, 0.84% S, 12.54% Na, 3.08% Cl, 945 mg/kg of Zn, 854 mg/kg of Mn, 1,660 mg/kg of Fe, 251 mg/kg of Cu, 19 mg/kg of I, 10 mg/kg of Se, 25 mg/kg of Co, 23,591 IU/kg of vitamin A, 8,493 IU/kg of vitamin D_3, 236 IU/kg of vitamin E, and 480 mg/kg of monensin.

[2]Rumen-degradable protein calculated using the NRC (2001).

[3]Hemicellulose = NDF – ADF.

[4]NFC = 100 – CP – NDF – ether extract – ash.