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Effects of partial replacement of corn and alfalfa silage with tall fescue hay on total-tract digestibility and lactation performance in dairy cows

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ABSTRACT

Our objective was to evaluate the effects of replacing either corn or alfalfa silage with tall fescue hay on total-tract neutral detergent fiber (NDF) digestibility and lactation performance in dairy cows. Twenty-four primiparous (75 ± 35 d in milk) and 40 multiparous (68 ± 19 d in milk) Holstein cows were blocked by parity and randomly assigned to 1 of 4 treatment groups in a pen equipped with 32 feeding gates to record intake by cow. Each gate was randomly assigned to 1 treatment group; thus, each cow had access to all 8 gates within the respective treatment and cow was the experimental unit. Treatments were formulated to replace either corn silage (CS) or alfalfa silage (AS) with tall fescue hay (TF) as follows (DM basis): 33% AS and 67% CS (control; 33AS67CS), 60% TF and 40% AS (60TF40AS), 60% TF and 40% CS (60TF40CS), and 33% TF and 67% CS (33TF67CS). The experiment was a 7-wk continuous lactation trial with a 2-wk covariate period. Milk production did not differ among treatments and averaged 40.4 kg/d. Fat yield and concentration and protein yield and concentration did not differ among treatments and averaged 1.58 kg/d, 3.94%, 1.28 kg/d, and 3.15%, respectively. Dry matter intake was greater for 33AS67CS (24.5 kg/d) compared with 60TF40CS (22.1 kg/d) and 33TF67CS (22.7 kg/d), and tended to be greater than 60TF40AS (23.2 kg/d). In vivo total-tract dry matter digestibility did not differ among treatments and averaged 66.2%. In vivo total-tract NDF digestibility was lower for 33AS67CS (37.8%) compared with 60TF40AS (44.4%) and 33TF67CS (45.3%), and similar to 60TF40CS (42.4%). In vivo total-tract NDF digestibility and an estimate of in situ total-tract NDF digestibility were similar between techniques across all treatment diets (42.3 vs. 42.6%, respectively). Inclusion of tall fescue grass hay increased the total-tract NDF digestibility of the diet and has the potential to replace corn silage and alfalfa silage and maintain milk production if economically feasible based on current market prices.

Key words: neutral detergent fiber, fiber digestion, tall fescue, dairy cow

INTRODUCTION

Lactating dairy cow DMI is limited by rumen distension as NDF levels in the ration increase (Allen, 1996), particularly when energy requirements are high (Allen, 2014). Grasses typically have a higher NDF content compared with alfalfa and corn silages (NRC, 2001), and alfalfa and corn silages have become commonplace in high-producing dairy cow rations due to superior DM digestibility (Hoffman, et al., 1993). Improvements in NDF digestibility in corn silage (Ferraretto and Shaver, 2015; Ferraretto et al., 2015) and alfalfa silage (Turnbull et al., 1982) have improved DMI and milk production. Similarly, incorporation of highly digestible NDF in grasses in the ration has the potential to increase DMI and milk production (Rinne et al., 2002; Cherney et al., 2004; Kuoppala et al., 2008) or maintain DMI and increase milk fat (Kendall et al., 2009).

Modern varieties of cool season grasses are bred to have greater NDF digestibility; tall fescue grass can contain greater than 50% NDF and have an in vitro 48-h NDF digestibility of up to 75% of NDF (Brink et al., 2010; Pelletier et al., 2010). Fiber digestibility of grasses can be influenced by many factors. Agronomic practices, such as harvesting earlier (Hoffman et al., 1993; Rinne et al., 2002) or harvesting from spring growth (Rinne et al., 2002; Cherney et al., 2004; Pelletier et al., 2010), increase NDF digestibility. Although varieties of tall fescue with endophytes have been associated with toxicosis and poor cattle performance (Foote et al., 2013), modern varieties of tall fescue have been bred to be free of endophytes and have been shown to improve milk production compared with their infected counterparts (Strahan et al., 1987). Thus, incorporating a cool season, perennial grass, such as endophyte-free tall fescue, may allow for increased digestible NDF in a ration fed to lactating dairy cattle.

A novel tool to predict total-tract NDF digestibility (**TTNDFD**) has recently been developed (Lopes et al.,

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Table 1. Nutrient composition of forages (mean ± SD)

Item (% of DM, unless noted)	Alfalfa silage	Corn silage	Tall fescue hay
DM (% as fed)	34.4 ± 2.6	37.3 ± 6.2	83.5 ± 0.6
OM	89.6 ± 1.6	96.4 ± 0.2	89.3 ± 1.6
CP	21.9 ± 1.3	7.7 ± 1.6	14.3 ± 0.8
Starch	0.4 ± 0.1	35.6 ± 3.9	1.6 ± 0.2
Lignin	9.4 ± 0.5	3.6 ± 0.3	8.1 ± 1.0
Ether extract	3.2 ± 0.7	3.8 ± 0.5	3.0 ± 0.5
NDF	44.9 ± 2.5	38.0 ± 1.5	64.4 ± 1.7
iNDF[1]	18.9 ± 2.0	9.2 ± 0.7	16.9 ± 1.4
iNDF[1] (% of NDF)	41.2 ± 1.2	25.8 ± 1.2	26.6 ± 0.3
pdNDF kd[2] (%/h)	5.1 ± 0.2	2.1 ± 0.1	2.9 ± 0.3
TTNDFD[3] (% of total NDF)	42.8 ± 1.4	36.2 ± 0.3	42.4 ± 2.2

[1]iNDF = indigestible NDF determined by in situ incubation for 288 h.

[2]pdNDF kd = potentially digestible NDF fraction digestion rate calculated from TTNDFD model.

[3]TTNDFD = predicted total-tract NDF digestibility using in situ TTNDFD model.

2015a) using an in vitro fermentation assay to measure the proportion potentially digestible NDF and rate of digestion of NDF. Although the model has been validated in high-producing cows at different intake levels (Lopes et al., 2015a), with different alfalfa-to-corn silage ratios (Lopes et al. 2015b), and across several TMR incorporating a diverse array of forage silages (Lopes et al., 2015c), the model has not been validated to in vivo NDF digestion data in grass hay. Thus, the objectives of the present study were to evaluate the effects of replacing either corn silage or alfalfa silage with tall fescue hay on lactation performance and to compare estimates of total-tract fiber digestibility as predicted by the TTNDFD model to in vivo measurements.

MATERIALS AND METHODS

Description of the Experiment

The experimental protocol was approved by the Animal Care and Use Committee of the College of Agriculture and Life Sciences at the University of Wisconsin-Madison. Twenty-four primiparous (75 ± 35 DIM; mean ± SD) and 40 multiparous (68 ± 19 DIM) lactating Holstein dairy cows were housed in a pen equipped with Insentec Roughage Intake Control system gates (Insentec BV, Marknesse, the Netherlands) in a freestall barn at the University of Wisconsin-Madison Emmons-Blaine Arlington dairy facility. The Roughage Intake Control feeding gates recorded individual cow feed intake continuously. Cows were blocked by parity and randomly assigned to 1 of 4 treatment groups. Each of 32 feeding gates was randomly assigned to 1 treatment group; thus, each cow had access to all 8 gates within the respective treatment group, and cow was the experimental unit.

Treatments were formulated to replace either corn silage (**CS**) or alfalfa silage (**AS**) with tall fescue hay (**TF**; Table 1). Bariane Tall Fescue (Barenbrug USA, Tangent, OR) was planted in separate field plots at a rate of 22.42 kg/ha at the University of Wisconsin-Arlington Agricultural Research Station (Arlington, WI) on September 15, 2011, with a no-till drill. For this feeding trial, the forage was cut on June 18, 2013 (first cut), between the boot and heading stage of maturity and baled in large square bales on June 21, 2013. The bales were stored in an enclosed shed for approximately 8 mo before trial initiation.

Diets were formulated to contain similar CP and starch concentrations, whereas dietary NDF and indigestible NDF (**iNDF**) levels were allowed to change (Table 2). Treatments were as follows, with diet names abbreviated by the proportion that each forage contributes to the total forage component of each TMR: 33% AS and 67% CS (control; **33AS67CS**), 60% TF and 40% AS (**60TF40AS**), 60% TF and 40% CS (**60TF40CS**), and 33% TF and 67% CS (**33TF67CS**). All cows received bST (Posilac, Elanco Animal Health, Greenfield, IN) every 14 d through the duration of the trial, initiated during the covariate period. The experiment was a continuous lactation trial, beginning with a 2-wk covariate period before 7 wk of assignment to treatment diets.

Cows were fed a TMR with feed delivered 3 times daily at 0300, 1200, and 1500 h, and were offered free access to water. The TMR was mixed once daily before the midday feeding and stored for delivery in the afternoon and the following morning. Cows were fed ad libitum for 10% refusals. Dry matter content of the forages was measured once weekly, and as-fed ingredient proportions were modified accordingly to maintain near constant proportions of feeds on a DM basis.