SHORT COMMUNICATION

Nitrogen Retention and Nutrient Digestibility in Geldings Fed Grass Hay, Alfalfa Hay, or Alfalfa Cubes

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ABSTRACT

This study was conducted to determine whether feeding different physical forms of hay alters nutrient digestibility and nitrogen retention (NR). Six Quarter Horse geldings were assigned to any one of three different dietary treatments in three 14-day periods. The diets included long-stem Bermuda grass hay (G), long-stem alfalfa hay (A), and alfalfa cubes (C). In the final 4 days of each period, horses were fitted with harnesses for total collection of urine and feces. Samples of feed, orts, feces, and urine were analyzed for dry matter, organic matter, acid detergent fiber, neutral detergent fiber, and nitrogen (N). Digestibility of dry matter, organic matter, and N was greatest for A, intermediate for C, and smallest for G ($P < .05$). Digestibility of acid detergent fiber was greater ($P < .05$) for A than G or C, and neutral detergent fiber digestibility was greater ($P < .05$) for A or G than C. Nitrogen intake (NI) was greatest for A, intermediate for C, and smallest for G ($P < .05$). Fecal N excretion was not different between diets, but urine N excretion was greater ($P < .05$) for A and C as compared with G. When expressed as a percentage of NI, NR did not differ among diets. We concluded that NR in mature horses increases with NI, but N utilization is not significantly influenced by the physical form or crude protein content of the hay fed. Potential differences in fiber digestibility and daily fecal output are factors to consider when incorporating processed forages into feeding programs of horses.

Keywords: Horse; Hay; Nitrogen retention; Forage digestibility

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INTRODUCTION

Owners are known to feed mature horses an all forage diet, with little concern for nutrient balance in the diet. On this feeding program, horses perform adequately and maintain their body condition; however, the effect of this regimen on nitrogen (N) metabolism in the horse and N excretion into the environment is unclear. Generally, excess dietary protein is metabolized and excreted as urea in the urine.[1] Previous work with ponies showed that N retention (NR) as a percentage of N intake (NI) differed when fed Bermuda grass versus alfalfa hay.[2]

Recent drought conditions in the United States sparked renewed interest in alternatives to hay for horses. Previous studies have shown the value of hay cubes as a replacement for other types of forage or roughage in horses. Advantages of feeding cubes as compared with long stem hay include ease of handling and weighing to control intake, decreased storage space requirement, and potentially greater body weight gain as a result of less feed waste during consumption.[3-5] Although the effect of forage form on nutrient digestibility has been documented,[3,4,6,7] the effect on NR is not well defined.

The objective of our study was to determine whether apparent nutrient digestibility and NR differs among mature sedentary horses fed long-stem Bermuda grass, alfalfa hay, or commercially available alfalfa cubes.

MATERIALS AND METHODS

Management protocols and experimental procedures used in this study were approved by the New Mexico State University Institutional Animal Care and Use Committee. Six Quarter Horse geldings (age = 13.3 ± 1.6 years; weight = 538 ± 11 kg) were randomly assigned to one of three dietary treatments in a duplicated 3 × 3 Latin Square. The diets included long-stem Bermuda grass hay (G), long-stem alfalfa hay (A), and alfalfa cubes (C; Table 1). The total daily ration of 1.4% body weight dry matter was split between feedings at 7:00 A.M. and 7:00 P.M. The daily rations provided on an average the following percentages of digestible energy and crude protein (CP)

Table 1. Analysis of Bermuda grass (G), alfalfa hay (A), or alfalfa cubes (C)

Item (100% DM basis)	G	A	C
% DM	92.6	90.7	89.5
Digestible energy (Mcal/kg, calculated[a])	2.13	2.56	2.43
% Crude protein	8.8	22.6	17.4
% Acid detergent fiber	37.9	27.9	30.6
% Neutral detergent fiber	62.0	35.8	40.8

DM = dry matter.
[a] Digestible energy (kcal/kg DM) = 2118 + 12.18 (% crude protein) − 9.37 (% acid detergent fiber) − 3.83 (% hemicellulose) + 47.18 (% fat) + 20.35 (% nonstructural carbohydrate) − 26.3 (% ash).[1]

requirements, respectively, as recommended by the 2007 National Research Council[1] Nutrient Requirements of Horses for sedentary horses: G, 98.6% and 114.9%; A, 118.5% and 292.9%; C, 112.5 % and 237.7%. Horses had ad libitum salt and water available in their individual 3.6 × 3.6 m^2 stalls.

The study involved sampling during three 14-day periods, which included a 10-day adaptation period followed by a 4-day total collection period to determine apparent total tract nutrient digestibility and NR. Horses were fitted with harnesses (The Horse Diaper, Equisan Marketing Pty. Ltd., South Melbourne, Victoria, Australia) for collection of urine and feces at 1:00 A.M., 7:00 A.M., 1:00 P.M., and 7:00 P.M. daily. At 10:00 A.M. on the final day of each collection period, a 9-mL blood sample from each horse was obtained by jugular venipuncture for analysis of serum urea nitrogen. Representative samples of each diet were obtained daily at 7:00 A.M., and orts were collected daily at 6:00 A.M. and 6:00 P.M.. Daily dietary treatment, orts, fecal, and urine samples were weighed, composited, and a representative sample (10% subsample for orts and feces, and 1% subsample for urine) of each was frozen until analyzed for dry matter (DM), organic matter (OM), acid detergent fiber (ADF), neutral detergent fiber (NDF), and N.

Laboratory Analysis

Hay, feces, and orts samples were dried in a forced-air oven (Model # POM-326F, Blue M Electric Company, Blue Island, IL) at 55°C for 72 hours. They were allowed to air equilibrate, weighed to determine moisture loss, and ground in a Wiley mill to pass a 2-mm screen. Subsamples were then dried in a convection oven (Precision Scientific Group, Chicago, IL) at 105°C for 24 hours, and total DM was calculated as the product of 105°C and 55°C analyses. Samples were analyzed for OM in a muffle furnace (Thermolyne Corp., Dubuque, IA) at 500°C for 8 hours, and for NDF and ADF using an ANKOM 200 Fiber Analyzer (ANKOM Technology Corp., Fairport, NY). Total N was analyzed in each of the samples by total combustion (LECO FP-528, LECO Corporation, St. Joseph, MI). Urea-N concentrations of serum were determined colorimetrically where 4-μL serum samples were each treated with 200 μL of urease reagent (Infinity TR12421, Thermo Scientific, Waltham, MA) in 96-well plates. After mixing for 15 seconds, plates were incubated at 37°C for 5 minutes followed by incubation at 4°C for 5 minutes. Plates were immediately read at 340 nm on a microplate reader (Biotek ELx808, Biotek Instruments Inc., Winooski, VT).

Table 2. Apparent total tract nutrient digestibility and nitrogen (N) retention in horses fed Bermuda grass (G), alfalfa hay (A), or alfalfa cubes (C)

Item	G	A	C	±SEM
Digestibility (%)				
Dry matter	54.58[a]	72.75[b]	68.29[c]	0.66
Organic matter	56.95[a]	73.11[b]	69.08[c]	0.66
Acid detergent fiber	51.18[a]	55.08[b]	47.98[a]	1.12
Neutral detergent fiber	55.48[a]	56.61[a]	50.31[b]	1.15
N	62.27[a]	81.27[b]	78.16[c]	0.83
N intake (g/d)	121.40[a]	218.02[b]	212.69[c]	5.37
Fecal N (g/d)	45.79	40.85	45.91	1.89
Urine N (g/d)	45.98[a]	109.53[b]	98.48[b]	10.59
N retained (g/d)	29.64[a]	67.64[b]	68.30[b]	10.22
N retained (% of intake)	24.43	31.20	31.55	5.26

[a,b,c] Means within rows lacking common superscripts differ ($P < .05$).

Statistical Analysis

Data were analyzed with the MIXED procedure of SAS (SAS 9.1, Cary, NC) as a Latin Square design. Comparisons between treatments were made when a significant *F*-test ($P < .05$) for the main effect was found, and treatment differences were considered significant at ($P < .05$).

RESULTS

Digestibility of DM, OM, and N was greatest for A, intermediate for C, and smallest for G (Table 2). Digestibility of ADF was greater for A than G or C, and NDF digestibility was greater for A or G than C (Table 2).

N intake was greatest for A, intermediate for C, and smallest for G. Fecal N excretion was not different, but urine N excretion was greater for A and C as compared with G (Table 2). NR did not differ between diets when expressed as a percentage of NI although NR was greater for A and C as compared with G (Table 2). Serum urea-N was greater for A (15.85 mg/dL) and C (15.27 mg/