EFFECTS OF FREQUENCY OF OFFERING AND TYPE OF SUPPLEMENTAL FORAGE ON INTAKE AND DIGESTION IN CALVES CONSUMING ENDOPHYTE-INFECTED FESCUE HAY


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ABSTRACT

Two experiments were conducted to determine the effects of frequency of offering and type of supplemental forage on intake and digestion in calves consuming endophyte-infected fescue hay (1). In Exp. 1, five Holstein steers, averaging 128 kg body weight (BW), were used in a 5 x 5 Latin square experiment. All steers were given free access to I in the afternoon. Morning meals consisted of 1) ad libitum access to I daily (control), 2) 0.5% BW of Bermuda-grass hay (BG) daily, 3) 1.0% BW of BG every 2nd d, 4) 1.5% BW of BG every 3rd d and 5) 2.0% BW of BG every 4th d. Steers receiving BG consumed less (P<.01) I and more (P<.01) total dry matter (DM) than did steers given I alone. Within treatment, I intake was similar (P>.10) among days of the feeding cycle without BG. Organic matter (OM) digestion was lower (P<.05) with than without BG. In Exp. 2, 12 beef calves (Angus and Hereford × Angus; 6 mo of age, 155 kg initial BW) were used in a completely randomized-design experiment. Calves were given ad libitum access to I daily (control) or to BG or wheat hay (WH) on d 1 and I the following 3 d. Hay (I, BG or WH) intake d 1 of the feeding cycle was higher for BG and WH than for the control treatment (16 and 45%, respectively) and higher for WH than BG (25%; P<.05). Fescue intake other days was similar among treatments, and differences within treatments between days were nonsignificant. Digestion of OM ranked WH > control > BG (P<.05). Intake of diets high in I can be elevated by daily or intermittent offering of nontoxic forage.

(Key Words: Cattle, Festuca, Forage, Supplements, Intake, Digestion.)

Introduction

Feed intake of ruminants consuming diets high in fescue infected with the endophytic fungus Acremonium coenophialum is lower than expected based on classical chemical analyses of N, cell walls and lignin (Hemken et al., 1979, 1984; Keltner et al., 1985). Low ingestion of digestible nutrients most likely is a cause of low performance of animals consuming fescue toxicants (Goetsch et al., 1987a). Thus, offering a nutrient source to supplement those nutrients arising from the feeding of infected fescue or to increase the quantity of usable nutrients derived from fescue might increase animal performance. Benefit of supplementation that increases total intake but does not alter toxicant uptake by, or effects in, the host should depend on the toxicity-producing ability of the fescue source. Simple substitution of nontoxic feed for infected fescue with constant or declining intake would be of value if decreased toxicant uptake lessens severity of the toxicosis.

Even though cattle producers with infected fescue pastureland are commonly advised to dilute intake of toxic fescue, information regarding desired modes of supplementation is scarce. High levels of management necessary to maintain pastures of fescue mixed with other forage and input of labor to supplement nontoxic feed daily are deterrents to using supplementation. Therefore, this study was conducted to determine the effects of discontinuous or intermittent supplementation with nontoxic forage on intake and digestion in calves given ad libitum access to infected fescue.

Materials and Methods

Experiment 1. Five growing Holstein steers with average initial and final body weights (BW) of 117 and 138 kg, respectively, were used in a 5 x 5 Latin square experiment with periods lasting 24 d. Steers were tethered in an enclosed barn with free access to water. At experiment initiation and on d 24 of each period steers were weighed at 1300. Blood samples were collected by jugular venipuncture im-

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mediately thereafter, and serum was obtained by centrifugation and was frozen.

All steers were given ad libitum access to infected fescue hay (I; table 1) in the afternoon (105 to 110% of I consumption on previous comparable experimental days). Morning meals consisted of 1) ad libitum access to I daily (control), 2) .5% BW of Bermuda-grass hay (BG; table 1) daily (1 x), 3) 1.0% BW of BG every 2nd d (2 x), 4) 1.5% BW of BG every 3rd d (3 x) and 5) 2.0% BW of BG every 4th d (4 x). Fescue (postanthesis, milk stage) was 1.93% N, 73.8% neutral detergent fiber (NDF) and 6.3% acid detergent lignin (ADL); BG (mature) was 1.97% N, 82.8% NDF and 6.0% ADL. Concentrations of N-acetyl and N-formyl loline alkaloids in I were 140 and 1,286 mg/kg dry matter (DM), respectively. Fescue orts were collected, quantitated and discarded before the 0800 meal. Mineral supplement (30 g air-dry) of 50% dibasic calcium phosphate and 50% trace mineralized salt (>95% NaCl, .25% Mn, .2% Fe, .03% S, .033% Cu, .0025% Co, .007% I and .005% Zn, DM basis) was given at the 0800 meal.

Composite samples of hay were formed in each period. Fecal grab samples were collected every 8 h at 1400, 2200 and 0600 daily on d 21 to 24 for control, 1 x, 2 x and 4 x treatments, whereas samples were not taken on d 21 for the 3 x treatment. Absence of nonrandom effects of time, without evidence of daily or diurnal variation, on insoluble ash excretion in feces or derived digestion estimates has been observed (McCarthy et al., 1974; Van Keulen and Young, 1977; Thonney et al., 1985; Porter and Sniffen, 1986). Feces were dried at 55 C for 48 h, allowed to air-equilibrate and ground through a 1-mm screen; composite samples were formed on an air-dry basis. Hay samples were ground through a 1-mm screen. Hay and fecal composite samples were analyzed for DM, ash, N (AOAC, 1975), NDF (Goering and Van Soest, 1970) and acid insoluble ash (AIA) (Van Keulen and Young, 1977). Mean DM intake on d 13 to 24 and AIA intake and concentration in feces were used to determine fecal excretion and total tract disappearance of DM, organic matter (OM), NDF and N. Fescue orts were not considered for digestion estimation. Separation of seeds from hays before and during feeding was minimal; preferential refusal of seeds was not observed. Block et al. (1981) found consideration of ort composition unnecessary if orts made up no more than 10% of offered feed, as was the case in the present study. Further, Porter and Sniffen (1985) found no effect of ort analysis on estimates of digestion with a total mixed dairy-cow diet. Hay samples also were analyzed for acid detergent fiber (ADF), ADL (Goering and Van Soest, 1970) and loline alkaloids (Henson et al., 1987). Serum was thawed at room temperature and analyzed for prolactin by radioimmunoassay (Henson et al., 1987).

Total and fescue intake data averaged within feeding cycle for d 13 to 24 and within experimental day type (1-d cycle for control and 1 x, 2-d cycle for 2 x, 3-d cycle for 3 x, 4-d cycle for 4 x) were expressed as grams per day and percentage of BW by dividing kilograms DM intake by average BW within period. Data were subjected to analysis of variance using the General Linear Models Procedures of the SAS (1985) considering steer, period and diet in the statistical model. A contrast between the con-

<table>
<thead>
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<th>TABLE 1. COMPOSITION OF HAYS FED TO GROWING DAIRY STEERSa</th>
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<tbody>
<tr>
<td>Item</td>
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</tr>
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</tr>
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</tr>
<tr>
<td>Cellulose</td>
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<td>Hemicellulose</td>
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</table>

bPercentage of dry matter.

aPercentage of air-dry.
control treatment and those treatments with supplemental BG was made; linear and quadratic effects of frequency or level of BG supplementation in a day were determined. Simple correlations were performed. Standardized partial regression coefficients of intake and digestion as a percentage of intake for prediction of ingested digestible DM, OM, NDF and N were determined.

Experiment 2. Twelve crossbred beef calves (Angus and Angus × Hereford, 6 mo of age, average initial BW of 155 kg), six steers and six heifers, were assigned by weight and sex to three treatments in a completely randomized-design experiment lasting 64 d. Animals were housed individually in a partially open-front barn with an earth floor in 2.2- × 1.9-m pens with water available ad libitum. Wood chips and rice hulls were used for bedding. At 1500, a grain supplement consisting of 46.4% soybean meal, 46.4% ground corn, 3.6% trace mineralized salt and 3.6% limestone was offered to steers at .5% BW and to heifers at .45% BW (DM basis) after hay orts were collected, quantitated and discarded. Supplement was consumed in less than 15 min, after which I, BG or wheat hay (WH; table 1) was dispensed into feeders at 52.5 to 55% of the consumption on days preceding comparable experiment. An equivalent amount of hay was given the next morning at 0800. The control treatment (C) consisted of I fed daily. Fescue (mature, ripe seed removed) contained 1.25% N, 72.9% NDF and 6.1% ADL; BG (mature) contained 2.51% N, 77.2% NDF and 5.3% ADL; WH (dough stage) contained 1.54% N, 75.5% NDF and 5.7% ADL. In vitro NDF digestibility (IVNDFD) for I, BG and WH was 44.0, 51.9 and 67.1%, respectively. Fescue hay contained 448 mg/kg N-acetyl and 870 mg/kg DM N-formyl loline alkaloids, respectively. Treatments with substitute forages involved feeding ad libitum amounts of BG or WH 1 d (d 1) followed by I the 3 subsequent d (d 2, 3 and 4).

Animals were weighed at 1300 on consecutive days at the beginning and end of the experiment and at 16-d intervals within the trial. Blood samples were taken by jugular venipuncture at weighings on d 32, 48, 61, 62, 63 and 64. Serum was obtained by centrifugation and was frozen. Rectal digesta was sampled the last 4 d of the experiment at 1300, dried at 55 C for 48 h, allowed to air-equilibrate and ground through a 1-mm screen. Composite samples within animal were formed on an air-dry basis. Feed samples were obtained throughout the experiment and ground through a 1-mm screen; composite samples were constructed on an air-dry basis. Feed and fecal composite samples were analyzed for DM, ash, N, NDF and AIA. Intake of AIA was calculated from DM intake on d 60, 61, 62 and 63, and, with concentration of AIA in feces, was used to determine fecal excretion and total tract disappearance of DM, OM, NDF and N. Thonney et al. (1985) suggested that the number of fecal samples required to estimate digestion with the internal marker AIA decreases as feed AIA increases. To determine digestion of corn silage (.8% AIA, DM), four animals should be fecal-sampled (grab) five times or five animals should be sampled three times to achieve a 2-percentage-unit 95% confidence range (Thonney et al., 1985). In our trial, AIA was 2.0, 2.7 and .9% (DM) of I, BG and WH, respectively. Hence, four samples taken from each of four animals should have been adequate for the purposes of this experiment. Feed samples also were analyzed for ADF, ADL, IVNDFD (Van Soest et al., 1966) and loline alkaloids, and prolactin in serum was quantitated. Ruminal fluid for IVNDFD analysis was from two ruminally cannulated, mature Hereford cows fed medium-quality BG for BW maintenance and given free access to trace mineralized salt.

Calf sex was not considered because of nonsignificant effects. Treatment was used in the statistical model for most variables. Effects of time (16-d period or day within 4-d feeding cycle) on intake were nonsignificant. Hence, intake data were averaged for all days and for each of the 4 d within a feeding cycle. Live weights measured on consecutive days were averaged for estimation of average daily gain (ADG) and feed efficiency (gain/feed). Dry matter intake is expressed as the mean of percentages of average BW within 16-d periods. Effects of method of determination of NDF digestion (in vivo or predicted from NDF intake and IVNDFD), treatment and interactions were determined. Prolactin concentration was analyzed as a split plot with period or day within period as subplots. Other procedures were as in Exp. 1.

Results and Discussion

Experiment 1. Intake of I on d 13 to 24 (table 2) was similar to intake in experiments employing comparable conditions (Goetsch et al.,
Average daily I intake for control steers was higher (P<.01) than with supplemental BG. Mean I intake was similar (P>.10) among frequencies of BG offering. Bermuda-grass elevated (P<.10) total DM intake, but frequency of supplementation had no effect (P>.10). Infected fescue intake was less (P<.05) on days with than on days without supplemental BG. Steers receiving BG every other day (2 ×) consumed more (P<.07) total DM the day of BG offering, and total intake for 3 × and 4 × steers tended (P>.10) to be greatest the day BG was given. Total DM intake by growing dairy steers increased linearly as daily supplementation of an I diet with BG rose to 1.2% BW (Stokes et al., 1986), although most of the enhancement was with .6% BW of BG. In slight contrast, daily supplementation of growing dairy steers fed I with .5 or 1.0% BW of BG yielded intake substitution with .5% BW of BG, but higher total intake with 1.0% BW (Goetsch et al., 1987c).

Total DM intake (table 2) the day of BG offering was higher (P<.05) for 1 ×, 2 ×, 3 × and 4 × treatments than for the control group (standard error of .085). Total DM intake the day that BG was fed increased linearly (P<.01) with increasing level of BG (0, .5, 1.0, 1.5 and 2.0% BW). Likewise, I intake when BG was consumed declined linearly (P<.01) with increasing BG. Variations in amounts of I toxicants consumed the day of supplementation and BG ingested did not affect the quantity of fescue consumed on days when BG was not fed. Thus, conditions in the host set by I toxicants that affect intake do not appear modulated by short-term decreases in toxicant uptake.

Intake of I may be governed by mechanisms other than gut fill capacity (Goetsch et al., 1987a), as is implied by digestion measures in this experiment (table 3). A similar ADL concentration in the hays and NDF higher in BG than in I, coupled with greater resistance of warm- than of cool-season grasses to ruminal digestion (Van Soest, 1982; Akin, 1986), suggest that forage residue in the rumen was greater with than without BG. In contrast, total DM intake did not increase when limited amounts (.3% BW daily basis) of alfalfa hay were offered to steers consuming BG of slightly

### TABLE 2. EFFECTS OF FREQUENCY OF SUPPLEMENTATION WITH BERMUDA-GRASS HAY ON DRY MATTER INTAKE (PERCENTAGE OF BODY WEIGHT) IN GROWING DAIRY STEERS FED ENDOPHYTE-INFECTED FESCUE HAY AD LIBITUM (EXP. 1)

<table>
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<tr>
<th>Item</th>
<th>Day</th>
<th>C</th>
<th>1 x</th>
<th>2 x</th>
<th>3 x</th>
<th>4 x</th>
<th>SE</th>
<th>Effect</th>
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<td>.51</td>
<td>.51</td>
<td>.50</td>
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<tr>
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<tr>
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<td>.103</td>
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<tr>
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<td>2.37</td>
<td>2.36</td>
<td>2.43</td>
<td>2.43</td>
<td>.049</td>
<td>s</td>
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</table>

*C = control, infected fescue fed daily; 1 ×, 2 ×, 3 × and 4 ×: .5, 1.0, 1.5 or 2.0% body weight (dry matter) of Bermudagrass offered daily or every second, third or fourth day, respectively.

*dStandard error of the treatment mean based on five observations per treatment.

*’L = linear effect (P<.01) of frequency or level of Bermudagrass supplementation the day of supplementation (C and 1 ×: Mean; 2 ×, 3 × and 4 ×: d 1); S and s = difference between control and Bermudagrass-supplemented treatments (P<.01 and P<.10, respectively).

*Standard error of the day mean based on five observations per day.

*’Mean day intakes in a column within treatment group with different superscripts differ (P<.05).
lower quality than was used in the present experiment (unpublished data). Alfalfa was given daily or every 2nd (.6% BW), 3rd (.9% BW) or 4th d (1.2% BW).

Supplementation with BG increased fecal excretion of DM (P<.03) and OM (P<.04), whereas total tract digestion as a percentage of intake was depressed (DM, P<.04; OM, P<.05; table 3). Supplementation with BG increased intake and fecal excretion of NDF (P<.04) and decreased (P<.07) total tract NDF digestion. Fecal excretion of N was greater (P<.04) and total tract disappearance (P<.07) was lower with than without BG. Greater intake of nontoxic forage (BG) of lower inherent digestibility than I supports a limitation of I intake below a level set by gut fill capacity.

Digestibilities of DM, OM and NDF were not correlated (P>.10) with levels of intake although percentage of N disappearance was related to intake of N (r = .46; P<.03). Digestion as grams/day of DM, OM, NDF and N correlated with intakes. Likewise, standardized regression coefficients for prediction of intake of digestible matter indicated that intake explained 30, 32, 63 and 81% more variation than did percentage of digestion of ingested DM, OM, NDF and N, respectively.

### TABLE 3. EFFECTS OF FREQUENCY OF SUPPLEMENTATION WITH BERMUDA-GRASS HAY ON DIGESTION OF DRY MATTER, ORGANIC MATTER, NEUTRAL DETERGENT FIBER AND NITROGEN AND SERUM PROLACTIN IN GROWING DAIRY STEERS FED ENDOPHYTE-INFECTED FESCUE HAY AD LIBITUM (EXP. 1)

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>1×</th>
<th>2×</th>
<th>3×</th>
<th>4×</th>
<th>SEb</th>
<th>C vs othersc</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Passage, g/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<tr>
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<td>924</td>
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<td>1,084</td>
<td>1,123</td>
<td>1,133</td>
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<td>.03</td>
</tr>
<tr>
<td>Digestion Percentage</td>
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<td>61.4</td>
<td>61.7</td>
<td>61.0</td>
<td>1.69</td>
<td>.04</td>
</tr>
<tr>
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<td>1,776</td>
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<tr>
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<td>62.4</td>
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<tr>
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<td>1,660</td>
<td>1,681</td>
<td>44.8</td>
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<tr>
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<td>61.9</td>
<td>63.6</td>
<td>62.2</td>
<td>1.63</td>
<td>.07</td>
</tr>
<tr>
<td>Grams/d</td>
<td>36.6</td>
<td>35.1</td>
<td>35.5</td>
<td>35.6</td>
<td>36.0</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Serum prolactin level, ng/ml</td>
<td>.3</td>
<td>.1</td>
<td>.3</td>
<td>.6</td>
<td>.4</td>
<td>.20</td>
<td></td>
</tr>
</tbody>
</table>

aControl: infected fescue fed daily; 1×, 2×, 3× and 4×: .5, 1.0, 1.5 or 2.0% body weight (dry matter) of Bermuda grass offered daily or every second, third or fourth day, respectively.

bStandard error of the treatment mean based on five observations per treatment.

cSignificance level for control vs Bermuda-grass-supplemented treatment contrast.
Serum prolactin concentration was low and was similar among treatments (table 3). The experiment began in July and ended in November, 1985, and was conducted in Fayetteville, Arkansas. Thus, high temperature may have accentuated effects of I toxicants on animal functions (Hemken et al., 1981). Values are in a range observed in other experiments with similar conditions (Goetsch et al., 1987a,b). In the present experiment, blood samples were taken the last day of the feeding cycle; therefore, they may not depict prolactin concentration on earlier days in the feeding cycle.

Experiment 2. Composition of I and WH (table 1) was fairly similar, whereas BG contained the most N. Bermuda grass contained more hemicellulose and less cellulose than did the cool-season grasses. Fescue in Exp. 2 appeared of lower quality than in Exp. 1, and BG in Exp. 2 was of higher quality than in Exp. 1. In vitro NDF digestion for BG was slightly higher than expected in relation to I. Fine-grinding of sample and long incubation as compared with conditions in vivo may have been partially responsible. Differences between warm- and cool-season grasses in particle disruption with mastication could contribute to the finding that in vivo digestion of warm-season grasses was generally lower than that of cool-season grasses (Van Soest, 1982).

The level of N-acetyl loline alkaloid in I was greater in Exp. 2 than in Exp. 1 and in other I samples routinely analyzed in this laboratory, whereas the concentration of N-formyl loline alkaloid was lower. Effects of specific toxicants in I on intake and digestion and relationships to presence and levels of other toxicants are not clear.

Consumption of BG and WH (percentage of BW) on d 1 of the feeding cycle was greater than consumption of I (BG, 16% and WH, 45%; P<.05), and 24% more (P<.05) WH than BG was ingested (table 4). These differences are slightly less than in IVNDFD but do not correspond to NDF concentrations. Intake of hay and total DM was greater (P<.05) d 1 than d 2, 3 and 4 of the feeding cycle. Intake of I on d 2, 3 and 4 below gut capacity limitation may have facilitated intake of BG and WH higher than of I on d 1. Fescue intake during the 3 d after offering other forage was not altered (P>.10) by treatment or day. Mean total DM intake was similar (P>.10) among treat-

### TABLE 4. EFFECTS OF OFFERING BERMUDA GRASS (BG) OR WHEAT HAY (WH) EVERY FOURTH DAY ON DRY MATTER INTAKE (PERCENTAGE OF BODY WEIGHT) IN BEEF CALVES FED ENDOPHYTE-INFECTED FESCUE HAY AD LIBITUM OTHER DAYS (EXP. 2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Day</th>
<th>C</th>
<th>BG</th>
<th>WH</th>
<th>SE b</th>
<th>Significance level for contrasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Control vs others</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1.65</td>
<td>1.92f</td>
<td>2.39f</td>
<td>.147</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.66</td>
<td>1.60f</td>
<td>1.57f</td>
<td>.115</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.64</td>
<td>1.62f</td>
<td>1.63f</td>
<td>.119</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.63</td>
<td>1.58f</td>
<td>1.65f</td>
<td>.120</td>
<td>.05</td>
</tr>
<tr>
<td>Day SE</td>
<td></td>
<td>.145</td>
<td>.081</td>
<td>.141</td>
<td></td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>Avg</td>
<td>1.65</td>
<td>1.68</td>
<td>1.81</td>
<td>.144</td>
<td>.05</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2.12</td>
<td>2.39f</td>
<td>2.86f</td>
<td>.149</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2.14</td>
<td>2.07f</td>
<td>2.04f</td>
<td>.113</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.11</td>
<td>2.09f</td>
<td>2.10f</td>
<td>.116</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2.11</td>
<td>2.05f</td>
<td>2.12f</td>
<td>.118</td>
<td>.05</td>
</tr>
<tr>
<td>Day SE</td>
<td></td>
<td>.136</td>
<td>.084</td>
<td>.145</td>
<td></td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>Avg</td>
<td>2.12</td>
<td>2.15</td>
<td>2.28</td>
<td>.114</td>
<td>.05</td>
</tr>
</tbody>
</table>

aC: control, infected fescue fed daily; BG: Bermuda grass fed d 1 and infected fescue fed d 2, 3 and 4; WH: wheat hay fed d 1 and infected fescue fed d 2, 3 and 4.

bStandard error of the treatment mean based on four observations per treatment.

cStandard error of the day mean based on four observations per day.

dSum of forage and concentrate supplement intake (.45 and .50% body weight for heifers and steers, respectively).

fMean day intakes in the same column within treatment group with different superscripts differ (P<.05).
ments. Total DM intake d 1 of the feeding cycle for BG steers was 15% greater than the average of d 2, 3 and 4. The slightly lower difference (10%) for 4 × steers in Exp. 1 may have been due to variation in I source between experiments or to consumption of I all days in Exp. 1 vs 3 of every 4 d in Exp. 2.

Total tract digestibilities of DM (percentage), OM (percentage) and NDF (percentage and g/d) were greatest for WH, lowest for BG and intermediate for C (P < .05; table 5). Total tract N disappearances were not affected (P > .10) by treatment. Intake and percentage of digestibilities of DM, OM, NDF and N were not related (P > .10). Standardized partial regression coefficients for prediction of ingested digestible matter revealed that intake explained 53, 50, 23 and 98% more variation than did percentage of digestion of DM, OM, NDF and N, respectively. Intake of diets high in I appears to be a more important controller of nutrient acquirement, and thus animal performance, than does digestion. Nearly twice as much variation in intake of digested N was explained by intake than by percentage of digestion in both experiments; with medium- to low-quality forage diets, greatest regulation of host N uptake seems to be through intake.

A portion of the increase in digestion when WH was offered every 4th d probably was because of ingestion of more highly digestible DM. But, for the alteration in digestion with BG, means other than a change in the proportion of ingested potentially digestible matter must have been involved. Ruminal OM and NDF digestion in limit-fed beef cows increased linearly as BG was substituted for I (Jones et al., 1987a). Further, additions of up to 1.2% BW of BG to I diets increased total intake linearly in growing dairy steers but did not affect total tract digestion (Jones et al., 1987a; Goetsch et al., 1987c). Hence, low digestion in BG steers may relate to level and infrequency of supplementation. Absence of fescue consumption the day of BG supplementation may have been involved as well, because digestion in Exp. 1 declined with all BG treatments.

Digestion of NDF predicted from IVNDFD and NDF intake was 45.5, 47.3 and 52.0 for C, BG and WH treatments, respectively, with

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>BG</th>
<th>WH</th>
<th>SEb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake, g</td>
<td>3,264</td>
<td>3,276</td>
<td>3,737</td>
<td>402.6</td>
</tr>
<tr>
<td>Fecal excretion, g/d</td>
<td>1,481</td>
<td>1,797</td>
<td>1,429</td>
<td>199.9</td>
</tr>
<tr>
<td>Digestion, %</td>
<td>54.6d</td>
<td>45.5c</td>
<td>61.7c</td>
<td>1.92</td>
</tr>
<tr>
<td>Digestion, g/d</td>
<td>1,783</td>
<td>1,479</td>
<td>2,308</td>
<td>228.4</td>
</tr>
<tr>
<td>Organic matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake, g/d</td>
<td>2,936</td>
<td>2,946</td>
<td>3,368</td>
<td>365.4</td>
</tr>
<tr>
<td>Fecal excretion, g/d</td>
<td>1,302</td>
<td>1,606</td>
<td>1,257</td>
<td>181.1</td>
</tr>
<tr>
<td>Digestion, %</td>
<td>55.6d</td>
<td>45.8c</td>
<td>62.7e</td>
<td>2.12</td>
</tr>
<tr>
<td>Digestion, g/d</td>
<td>1,634</td>
<td>1,340</td>
<td>2,111</td>
<td>211.3</td>
</tr>
<tr>
<td>Neutral detergent fiber</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake, g/d</td>
<td>1,853</td>
<td>1,888</td>
<td>2,207</td>
<td>256.9</td>
</tr>
<tr>
<td>Fecal excretion, g/d</td>
<td>950</td>
<td>1,146</td>
<td>865</td>
<td>132.7</td>
</tr>
<tr>
<td>Digestion, %</td>
<td>48.3d</td>
<td>39.7c</td>
<td>60.7c</td>
<td>2.11</td>
</tr>
<tr>
<td>Digestion, g/d</td>
<td>903d</td>
<td>743c</td>
<td>1,342e</td>
<td>141.1</td>
</tr>
<tr>
<td>Nitrogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake, g/d</td>
<td>69.5</td>
<td>77.5</td>
<td>78.6</td>
<td>7.70</td>
</tr>
<tr>
<td>Fecal excretion, g/d</td>
<td>27.7</td>
<td>34.2</td>
<td>27.3</td>
<td>3.23</td>
</tr>
<tr>
<td>Digestion, %</td>
<td>60.2</td>
<td>55.9</td>
<td>64.9</td>
<td>2.27</td>
</tr>
<tr>
<td>Digestion, g/d</td>
<td>41.7</td>
<td>43.3</td>
<td>51.4</td>
<td>5.29</td>
</tr>
</tbody>
</table>

°C: Control, infected fescue fed daily; BG: Bermuda grass fed d 1 and infected fescue fed d 2, 3 and 4; WH: wheat hay fed d 1 and infected fescue fed d 2, 3 and 4.

SEb: Standard error of the treatment mean based on four observations per treatment.

c.d.e: Means in a row with different superscripts differ (P < .05).
Supplemental forage for cattle consuming fescue

Highest (P<.05) digestion for WH. An interaction existed (P<.05) between method of determination of NDF digestion (actual and predicted) and treatment. Predicted digestion of NDF was fairly close to actual for control steers but was higher than actual for BG and lower for WH. Hence, WH offered every 4th d when I was given the other 3 d affected digestion of NDF positively, whereas BG feeding every 4th d resulted in a negative associative effect. Perhaps alterations in the ruminal environment caused by substitution of BG or WH for I were responsible for these effects.

Because WH, like fescue, is a cool-season grass, only a small change in NDF digestion other than an increase of a magnitude determined by differences in intake and IVNDFD between WH and I was expected. Toxicants in I may have allowed the greater-than-expected change to occur. Effects of perloline, a diazophenanthrene alkaloid sometimes present in infected fescue, on microbial digestion have been observed (Bush et al., 1972; Boling et al., 1975). If toxicants in fescue can depress ruminal digestion, WH fed every 4th d could have transiently alleviated such effects and permitted maximal WH digestion and elevated digestion of I originating from preceding or subsequent meals. However, deleterious effects of toxicants contained in I on in vivo digestion have not been detected (Goetsch et al., 1987a,c). On the day it was offered, high intake of highly digestible WH should have facilitated a larger or more active population of ruminal microbes than were present in control steers. This may have provided a positive carryover effect on microbial activity, enhancing I digestion on days subsequent to consumption of WH.

Adaptation of the ruminal environment created by feeding different types of grass for maximum digestion of each type and ability of adapted environments to digest other forages maximally have been suggested (Akin, 1986). Differences between warm- and cool-season grasses in makeup and arrangement of tissues suggest that conditions in the rumen with certain forage types could be dissimilar to conditions with others (Akin, 1986). Effects of fescue toxicants on capacity of ruminal microbes for digestion or stability in regard to dietary manipulation have not been determined. However, Jones et al. (1987a,b,c) observed similar changes in ruminal digestion with I and BG hays when limit-fed to beef cows together or with clover in various proportions. But, switching from ad libitum consumption of I to BG for a day and then back to I for 3 d may have drastically altered microfloral status to depress digestion.

Performance data (table 6) were similar...

### Table 6. Effects of offering Bermuda grass or wheat hay every fourth day on live weight, average daily gain, feed efficiency and serum prolactin in beef calves fed endophyte-infected fescue hay ad libitum other days (Exp. 2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>C</th>
<th>BG</th>
<th>WH</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight, kg</td>
<td></td>
<td>156.3</td>
<td>153.0</td>
<td>154.3</td>
<td>9.64</td>
</tr>
<tr>
<td>Final weight, kg</td>
<td></td>
<td>167.0</td>
<td>166.4</td>
<td>170.7</td>
<td>13.12</td>
</tr>
<tr>
<td>Average daily gain, kg/d</td>
<td></td>
<td>.19</td>
<td>.24</td>
<td>.29</td>
<td>.091</td>
</tr>
<tr>
<td>Feed efficiency, gain/feed</td>
<td></td>
<td>.04</td>
<td>.06</td>
<td>.07</td>
<td>.018</td>
</tr>
<tr>
<td>Serum prolactin, ng/ml&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Period 2, d&lt;sup&gt;b&lt;/sup&gt; 1</td>
<td>6.2</td>
<td>20.6</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Period 3, d&lt;sup&gt;b&lt;/sup&gt; 1</td>
<td>13.0</td>
<td>15.5</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 1</td>
<td>12.0</td>
<td>99.2</td>
<td>32.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 2</td>
<td>18.8</td>
<td>117.7</td>
<td>40.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 3</td>
<td>7.1</td>
<td>9.9</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 4</td>
<td>19.3</td>
<td>78.1</td>
<td>42.2</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>C: control, infected fescue fed daily; BG: Bermuda grass fed d 1 and infected fescue fed d 2, 3 and 4; WH: wheat hay fed d 1 and infected fescue fed d 2, 3 and 4.

<sup>b</sup>Standard error of the treatment mean based on four observations per treatment.

<sup>c</sup>Standard error = 23.13 for period means (d 4) and 33.59 for day means.

<sup>d</sup>Periods 2, 3 and 4 began 32, 48 and 64 d after experiment initiation.

<sup>e</sup>Infected fescue, Bermuda grass or wheat hay fed d 1; infected fescue fed d 2, 3 and 4.
Cold temperature may have been partially responsible because the experiment was conducted in the late fall of 1984 and early winter of 1985. Serum prolactin concentration (table 6) was not affected (P > .10) by treatment.

In conclusion, in Exp. 1 total tract digestion declined when BG was provided at 0.5% BW (daily basis) regardless of supplementation frequency, yet total DM intake rose with supplementation. In Exp. 2, offering BG or WH ad libitum every 4th d and 1 other days increased intake the day of substitution; intake increased to a greater extent with WH than BG. Digestion of NDF increased more than expected with WH but less than expected with BG.

**Literature Cited**


