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Short communication

Effect of the wild-type tall fescue endophyte on growth rate and feed consumption in nulliparous meat goat does

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ABSTRACT

Tall fescue is one of the primary pasture forages used to manage goats in the United States. Data are limited on how the wild-type endophyte (*Neotyphodium coenophialum*) found in most tall fescue stands affects meat goat performance. In two experiments across four summers, nulliparous yearling does were fed diets containing tall fescue seed to assess the effect of endophyte infection on goat growth and feed intake. In Experiment 1, does were fed endophyte-infected or endophyte-free tall fescue seeds added to the diets for 10 weeks. Feed refusals were weighed daily. The endophyte-infected diet reduced ($P<0.05$) weight gain and increased ($P<0.05$) feed refusals. In Experiment 2, feed refusal values of endophyte-infected pens were used to adjust feed offering to endophyte-free pens daily. When daily feed intake was equalized for endophyte-infected and endophyte-free pens, doe weight gain was still reduced by the endophyte-infected diet over 10 weeks. These data suggest that endophyte infection in tall fescue can adversely affect meat goat growth rates in a manner not totally dependent on nutrient intake levels.

1. Introduction

Tall fescue (*Festuca arundinacea*) is extensively grazed by livestock in the United States. Most tall fescue pastures are infected with the fungal endophyte *Neotyphodium coenophialum* (Bacon and Siegel, 1988; Glenn et al., 1996). The endophyte produces ergot alkaloids that are beneficial to grass performance, but are detrimental to animal performance. Meat goats represent an emerging livestock class in the U.S. often raised on tall fescue pasture. A survey of Tennessee goat producers revealed that two-thirds of pastures used by goat producers are classified as tall fescue (Leite-Browning et al., 2002).

Along with tall fescue, numerous other grasses and grains potentially consumed by goats may carry significant levels of ergot alkaloids (Strickland et al., 2011). Livestock consuming endophyte-infected grasses can experience significant production declines leading to economic losses (Ball, 1997). Growth, reproductive, and lactation rates are all negatively impacted in livestock ingesting ergot alkaloids associated with *Neotyphodium*. Fescue toxicosis affects various ruminant species including cattle (Paterson et al., 1995; Browning, 2004), sheep (Aldrich et al., 1993; Parish et al., 2003) and deer (Wolfe et al., 1998). The manifestations of fescue toxicosis may vary somewhat from species to species (Porter and Thompson, 1992).

Despite the global significance of dietary ergot alkaloids (Strickland et al., 2011) and the worldwide growth of goat production (Devendra, 2010; Browning et al., 2011), the occurrence of toxicosis in goats eating *Neotyphodium*-infected grass or ergot alkaloids is not well documented. In one case, goat kids consuming fescue (*Festuca octoflora*) experienced ergot poisoning (Hibbs and Wolf, 1982). The cause was attributed to ergotised (*Claviceps*) seed heads. Infection of the fescue by *Neotyphodium* was not considered in the case report. In another documented case a goat developed fat necrosis associated with fescue toxicosis (Smith et al., 2004). Goats may be classified as intermediate feeders

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as their feeding behavior is adaptive (Lu, 1988; Animut et al., 2005). Goats may consume significant amounts of grasses such as tall fescue in their daily diet. This is often the case in management systems where goats are maintained on pasture and hay. The objective of this study was to evaluate the influence of consuming wild-type tall fescue *Neotyphodium* on meat goat growth performance.

2. Materials and methods

2.1. Animal management

Over four consecutive years, meat goat yearling does were fed pretreatment diets followed by study diets containing tall fescue seed. In the first year, Spanish × Boer and Spanish × Kiko F1 does were used. Boer, Kiko, and Spanish purebreds were used in the last three years. These doe genotypes represent the three most popular meat goat breeds in the US (Browning et al., 2011). Each year, doe genotypes were balanced across treatments and pen replicates. From March to May in each year, does were fed daily a 16% CP pelleted feed (454 g/head) for two months pretreatment. From June to August, the pelleted pretreatment feed was replaced with a 16% CP textured feed (454 g/head) to serve as the tall fescue seed carrier during the treatment period. General goat management across the pretreatment and treatment periods included providing water, orchardgrass hay and minerals for *ad libitum* consumption. Ambient temperatures during the dietary treatments are presented in Table 1.

2.2. Experimental diets

In Year 1 and 2 (Experiment 1), 64 does (28.7 kg) were fed the pretreatment diet for 65 days before being placed on dietary treatments of endophyte-infected (EI) Kentucky-31 tall fescue ($n = 32$ does) and endophyte-free (EF) Fawn tall fescue seed ($n = 32$ does) for 70 days. The pretreatment period was part of the routine doeling development program and allowed for an assessment of relative growth performance to identify any inherent group differences in weight gain before starting the dietary treatments. The EI and EF seed were added to the supplement daily at 227 g/head by hand-mixing fresh seed into the supplement daily to ensure consistency of seed distribution throughout daily ration offering. Fescue diets were fed to three pen replicates per treatment each year for a total of 6 EI and 6 EF pens. There were 4–5 does per pen in Year 1 and 6 does per pen in Year 2. Diets were fed in the afternoon and feed refusals collected and weighed the following morning. Energy and protein levels were similar between the treatment rations (Table 2). The EI seed had a mean ergovaline concentration of 3.5 ppm and the E- seed had less than 0.1 ppm of ergovaline as determined by HPLC (Welty et al., 1994).

In Year 3 and 4 (Experiment 2), 88 does (32.2 kg) were fed the pretreatment diet for 80 days before being placed on EI ($n = 44$ does) and EF ($n = 44$ does) seed diets for 70 days. Fescue diets were fed to four pens per treatment each year for a total of 8 EI and 8 EF pens. There were 6 does per pen in Year 3 and 5 does per pen in Year 4. Rations were provided in the afternoon with refusals weighed the following morning. Feed refusals were not weighed on days when rain fell into feeders. The EI seed was added to the supplement daily at 227 g/head as described for Experiment 1. The EF seed was added to the supplement at 227 g on Day 1. From Day 2 to Day 70, the amount of EF seed provided was based on the consumption of EI seed by the replicate pair on previous day as estimated by feed refusal data. Seed intake was equalized during treatment as the supplement carrier was generally not found in refused feed collections. On days when precipitation prevented an accurate recording of feed refusal weight, the last recorded EI refusal amount was used to determine the EF offering. The EI seed contained 3.0 ppm of ergovaline; EF seed had less than 0.1 ppm. Data for four EF does were excluded because of health problems, two in each year (one for lameness, three for endoparasitism).

Table 1
Mean daily high and low temperatures (°C) during dietary treatment.

Month	Experiment 1		Experiment 2	
	High	Low	High	Low
June	29.6	19.5	31.1	18.8
July	31.4	21.2	32.4	21.2
August	31.1	20.1	35.1	23.3

Climatological data recorded by Nashville Office, National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Table 2
Chemical components (as-fed) of treatment diets.

Component	Experiment 1		Experiment 2	
	EI	EF	EI	EF
TDN (%)	71.69	71.32	73.26	74.25
Crude protein, (%)	14.79	14.62	15.06	14.91
Ergovaline (ppm)	1.16	<0.02	1.00	<0.03

2.3. Statistical analysis

Weight gain and daily feed refusals were analyzed by analysis of variance using the MIXED procedure of SAS (SAS, 2004) for a split-plot design as used in an earlier study (Browning, 2004). Diet was the whole-plot factor and genotype was the sub-plot factor. Fixed effects in the models included diet (EI or EF), genotype (Boer, Kiko, or Spanish), and diet × genotype interaction. Pen replicate nested within diet was included as a random effect. Genotype and diet × genotype were excluded from the model for pen feed refusals in Experiment 1. For the first year, genotype for Spanish × Boer and Spanish × Kiko does was designated by maternal breed (i.e., Boer or Kiko). Diet was tested using pen(diet) as the error term. The Tukey–Kramer procedure was used to compare least squares means.

3. Results

In Experiment 1, average daily weight gain (ADG) was not affected by breed × diet interactions. During the pretreatment period, weight gain did not vary between dietary

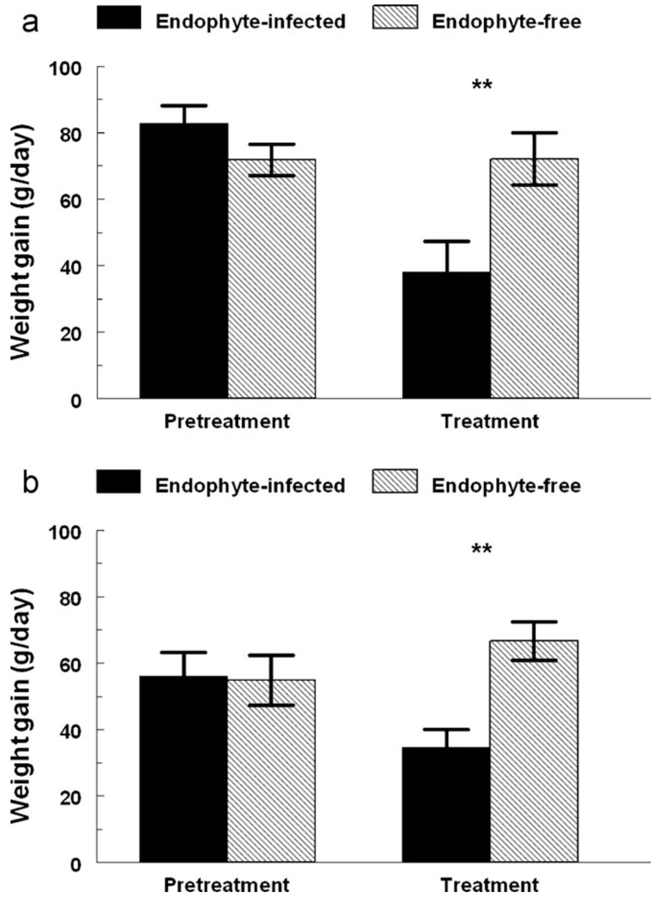

Fig. 1. Average daily weight gain (LSM ± SE) for meat goat does in (a) Experiment 1 and (b) Experiment 2. **Fescue type significantly differed ($P < 0.01$) for ADG during the treatment period.

groups (Fig. 1a) or doe genotypes (Table 3). Diet and genotype influenced ($P < 0.01$) ADG during the treatment period. Kiko does had higher ADG ($P < 0.01$) that Boer does (Table 3). Goats on EI seed diet had weight gain 47% lower compared with does on the EF seed diet (Fig. 1a). Feed refusals per goat were 98% greater ($P < 0.001$) in EI pens than in EF pens (101.6 ± 2.3 g/day vs. 1.6 ± 2.3 g/day). Feed refusals averaged 45% of offering in EI pens.

In Experiment 2, weight gains were not affected by breed × diet interactions. Dietary groups did not differ for ADG during the pretreatment period. Doe genotype affected ($P < 0.01$) weight gain during the pretreatment and treatment periods (Table 3). Kiko and Spanish does had higher ADG ($P < 0.05$) than Boer does pretreatment. Kiko does also gained weight at a greater rate ($P < 0.05$) than Boer and Spanish does during the treatment period (Table 3). Goats on EI diet had 48% lower ADG compared with does on the EF diet (Fig. 1b). Feed refusals per goat averaged 34 g/day (15% of offering) in EI pens.

4. Discussion

Breed differences for ADG were similar to differences reported among these genotypes during the preweaning period (Browning and Leite-Browning, 2011). Relative growth suppression responses to the EI diet in the goats were similar to observations in steers at this location (Browning, 2004). A reduction of ADG in goats on EI tall fescue could have a negative influence on market kid and replacement breeding stock development. The

Table 3
Effect of doe genotype on ADG (g) across diet groups.

Doe genotype	Experiment 1			Experiment 2		
	n	Pretreatment	Treatment	*n*	Pretreatment	Treatment
Boer	24	81.4 ± 4.7^{a}	34.0 ± 8.1^{b}	39	24.4 ± 7.4^{b}	34.2 ± 5.7^{b}
Kiko	32	84.4 ± 4.0^{a}	68.5 ± 6.8^{a}	26	72.7 ± 8.9^{a}	72.4 ± 6.9^{a}
Spanish	8	66.1 ± 8.9^{a}	62.8 ± 15.3^{ab}	19	69.5 ± 10.4^{a}	45.1 ± 8.1^{b}

Means within column not sharing a common superscript (a, b) differ ($P < 0.05$).

feed refusals of EI pens compared to EF pens on seed-based treatment diets are in agreement with other studies observing changes in feeding behavior in cattle and sheep exposed to EI tall fescue ergot alkaloids (Aldrich et al., 1993; Paterson et al., 1995). Burns and Fisher (2006) indicated that feed intake of goats tended to be reduced by wild-type EI tall fescue hay when compared with EF or novel EI.

The feeding protocol of using unprocessed seed in the current study was patterned after previous work at this location on cattle (Browning, 2004). There were no seed refusals and hyperthermia was evident in the cattle study. Does in the current study did not exhibit signs of thermal distress despite elevated summer temperatures and dietary ergovaline similar to those in the steer study (Browning, 2004). Unlike the cattle, the goats were able to sort out and avoid some of the EI seed when consuming the concentrate carrier. The selective feeding nature of goats has been reviewed in the past (Lu, 1988). In each of the four study years, no seed refusals occurred on Day 1. Refusals, virtually seed only, in the EI pens were consistently found from Day 2 to 70. The goats seemed to quickly alter their feeding behavior to reduce EI seed ingestion after the first day of ingesting the novel feed ingredient. The divergence in feeding behavior between EI and EF groups may reflect an acquired aversion response by EI goats as described by Provenza (1995) for a distress-inducing dietary component. In Experiment 2, equalizing feed intake did not eliminate the ADG difference between EI and EF goats. Fiorito et al. (1991) suggested that reduced growth rates in lambs on an EI diet involved more than a simple intake reduction. The findings of the current study appear to also imply that reduced ADG goes beyond changes in nutrient intake. Although not inducing clinical signs of animal distress typical of other livestock species, tall fescue containing the wild-type endophyte lowered weight gain in young meat goat does. Further studies on the impact of EI tall fescue on meat goat performance would benefit this emerging livestock industry.

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