Escherichia coli and Salmonella Shedding in Beef Cattle Grazing Tall Fescue

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Story in Brief

Fecal samples were obtained from Angus x Hereford cows (n = 49) and spring-born calves (n = 45) grazing endophyte-infected (E+) tall fescue or non-infected (E-) tall fescue during the summer to examine the effects on shedding of Escherichia coli O157:H7 (EHEC) and Salmonella (SM). Fecal samples were collected at 7:00 a.m. on each collection date (August 5th and 26th, 2002). One-half of the male calves were treated with a steroid implant at 60 days prior to fecal collection. Body temperature was measured from cattle at time of fecal collection. Mean ambient temperature and humidity at time of fecal collection(s) were 81°F and 77%, respectively. Overall, incidence of EHEC shedding averaged 8.4 and 7.6% for calves and cows, respectively. Salmonella shedding was 4.8 and 0% for calves and cows, respectively. Cows grazing E+ fescue were shedding fewer (P < 0.05) EHEC than cows grazing E- (1.8% vs 17% for E+ and E- cows, respectively). Likewise, EHEC shedding tended (P = 0.11) to be reduced in E+ calves (4.3%) compared with E- calves (13.9%). In calves, type of fescue grazed did not influence (P > 0.10) the incidence of SM shedding. Cow shedding of either EHEC or SM did not influence (P > 0.10) calf shedding of bacteria. Shedding of EHEC and SM in calves was not influenced (P > 0.10) by sex of calf or implant status. Shedding of E. coli O157:H7 tended to be reduced in calves and was decreased in cows grazing endophyte-infected tall fescue.

Introduction

Escherichia coli O157:H7 (EHEC) and Salmonella (SM) are two of the most common agents of foodborne illness in humans, and both bacteria have been isolated from beef cattle at all stages of production (Elder et al., 2000; Fedorka-Cray et al., 1998). Annually, pathogenic bacteria-related illnesses cost an estimated $2.9 to 6.7 billion (Buzby et al., 1996).

Recently, Fitzgerald et al. (2003) reported that the incidence of shedding of EHEC and SM tended to be increased by production stressors (i.e., milking status and lactation phase) in dairy cows. It is well documented that cattle grazing infected tall fescue during summer months are stressed and have reduced milk production, reproductive performance, and weight gain (Stuedemann and Hoveland, 1988).

A majority of the research investigating EHEC and SM shedding has been conducted on grain-fed cattle. A survey of 100 feedyards throughout the U.S. reported a 1.8% incidence of EHEC shedding (APHIS, 1995). Objectives of this study were to determine the: 1) influence of grazing endophyte-infected (E+) or non-infected (E-) tall fescue on shedding of EHEC and SM, 2) relationship of shedding EHEC and SM between cow and calf, and 3) influence of calf sex and steroid implant of male calves on bacteria shedding.

Experimental Procedures

All animal procedures used in this study were approved by the committee for animal welfare at the Dale Bumpers Small Farms Research Center. Mature Angus x Hereford cows (n = 49) and their spring-born calves (n = 45) were utilized in duplicate (August 5th and 26th, 2002) for fecal collection at 7:00 a.m. Vaccination of cattle and blood sampling for additional studies also occurred on both collection dates. Cows and their calves grazed either endophyte-infected (E+) tall fescue (Festuca arundinacea) or non-infected (E-) tall fescue. Approximately 15 grams of fecal material was obtained via rectal palpation using separate veterinary palpation sleeves. Fecal samples were placed in Whirlpacks™ (Modesto, CA), packed on ice, and shipped to the USDA-ARS Food and Feed Safety Research Laboratory, College Station, TX, to determine the prevalence of Escherichia coli O157:H7 (EHEC) and Salmonella (SM).

Salmonella isolation. Fecal material (3 to 5 grams) was enriched in 20 mL of tetrathionate broth for 24 h at 37°C. Post-enrichment of samples in Rapport-Vassilidis R10 broth was followed by streaking each sample on brilliant green agar with novobiocin for identification. Samples were characterized biochemically using lysine iron agar and triple sugar iron agar if they displayed typical morphology of Salmonella.

Escherichia coli O157:H7 isolation. A homogenous sample containing 10 grams of feces, vancomycin (8 mg/L; Sigma Co.), cefixime (0.5 mg/L; Lederle Laboratories), and cefsulodin (10 mg/L; Sigma Co.) was prepared. The suspension was incubated at 37°C for 6 h followed by immunomagnetic bead enrichment consisting of a 30 min incubation of 1 mL of GN (gram negative; Fisher Scientific) enrichment broth with 20 µL of anti-O157 immunomagnetic beads at 25°C containing 0.05% Tween 20 (Dynal, Lake Success, NY). Fifty microliters of bead suspension was spread plated on sorbitol MacConkey plates containing cefixime (0.05 mg/L) and potassium tellurite (2.5 mg/L; Difco Laboratories; SMACct). Three sorbitol-negative colonies displaying typical EHEC morphology were selected from each plate and confirmed by enzyme-linked immunossaay.

Heat stress parameters. Maximum ambient temperature and relative humidity were collected for each replicate from the Dale
Bumpers Small Farms Research Center in Booneville, Arkansas. A temperature-humidity index (THI) was calculated for day of fecal collections. Briefly, THI was calculated as follows: THI = 0.45 T + 0.55 TH - 31.9 H + 31.9 where T = dry bulb temperature expressed in °F and H = relative humidity/100.

One-half of the male calves were implanted (Synovex-C®, Fort Dodge Animal Health, Fort Dodge, IA) approximately 60 days prior to fecal collection. Body temperature of cows and calves was monitored via the rectum at time of fecal collection. Blood serum samples were collected at the second replicate by venipuncture of the tail into 15 mL tubes, placed on ice, and centrifuged (2,500 x g for 15 min) after 6 h of clotting. Samples were stored at -4°F until concentrations of prolactin were quantified. Intra-assay coefficient of variation was 9%. Sensitivity of the assay was 0.3 ng/mL. Fescue plant samples were harvested and sent to the College of Veterinary Medicine, Oregon State University, for quantification of concentrations of ergovaline.

Statistical Analyses. Chi-square analysis, using the FREQ procedure of SAS (SAS Inst., Inc., Cary, NC), was used to determine influence of forage, sex of calf, and implant status of male calves on shedding of EHEC and SM. Influence of maternal bacterial shedding on incidence of calf bacteria shedding also was analyzed by chi-square analysis.

Results and Discussion

Average ambient temperature and humidity at time of fecal collection were 81°F and 77%, respectively. A calculated THI of 84.5 was indicative of moderate heat stress at the time of fecal collection. Body temperature of cattle ranged from 104 to 106°F. There was a fescue treatment (E+ or E-) by age interaction (P < 0.001) for body temperature. Calves maintained on E- had the highest (P < 0.05) body temperature (106°F) of all cattle in the experiment. To decrease heat stress of E+ cattle during fecal collection, cows and calves consuming E- fescue were transported to the handling facility (approximately 1/4 mile) nearest to the E+ cattle, and E+ cattle were processed before E- cattle, presumably during cooler temperatures. Thus, handling and transporting of E- cattle during increased ambient temperatures may have contributed to increased body temperatures in this group compared with E+ cattle. Concentrations of ergovaline were 1,642 parts per billion (ppb) for the E+ fescue and 57 ppb for the E- fescue. Current research data indicate fescue toxicosis is induced in livestock at concentrations of ergovaline from 400 to 750 ppb. Concentrations of prolactin were reduced (P < 0.05) in E+ calves (14.6 ng/mL) compared with E- calves (62.3 ng/mL) indicating toxicity in cattle grazing E+ fescue.

Overall, incidence of EHEC shedding averaged 8.4 and 7.6% for calves and cows, respectively. Salmonella shedding was 4.8 and 0% for calves and cows, respectively. Body temperature of cattle or ambient temperature did not influence (P > 0.10) shedding of EHEC or SM in cows and calves. Previous researchers report that 1.8% (APHIS, 1995) to 28% (Elder et al., 2000) of fed cattle evaluated were positive for E. coli O157:H7. Furthermore, Salmonella was found in 4% of fecal samples and 38% of hide samples from feedlot cattle (Beach et al., 2002). Fitzgerald et al. (2003) reported the incidence of E. coli O157:H7 and Salmonella shedding was 56 and 53%, respectively, in dry-lot, confined dairy cows in the Southwest. Peak shedding of EHEC occurs in late summer and early fall, and seasonality of SM shedding also has been observed. The differences in prevalence of bacteria shedding between studies may be related to management of cattle, fecal sampling method, time of year samples were collected, and/or the culture technique used.

This is an initial report of data reporting the effects of grazing E+ and E- fescue on the incidence of EHEC and SM shedding in cows and their calves. Cows grazing E+ fescue shed less (P < 0.05) EHEC than cows grazing E- fescue (1.8% vs 17% for E+ and E- cows, respectively; Figure 1). Likewise, calves maintained on E+ fescue (4.3%) tended (P = 0.11) to shed less EHEC than calves on E- fescue (13.9%; Figure 1). In the current study, no cows shed SM, and SM shedding was not influenced (P > 0.10) by type of fescue (E+ or E-) in calves (Figure 2). These data suggest consumption of E+ fescue by cattle could reduce the incidence of fecal shedding of EHEC. However, the possibility of transportation stress affecting EHEC shedding in E+ cattle should be investigated. Further research, including in vitro studies, is necessary to fully understand the relationship of E+ fescue and the presence of ergot alkaloids with E. coli O157:H7 shedding.

Transmission and/or infection of the calf from the cow were not conclusive in the current study. Shedding of bacteria from cows was not associated (P > 0.10) with their calves shedding bacteria. Furthermore, EHEC or SM was not affected (P < 0.10) by sex of calf or implant status of male calves.

Implications

Knowledge of factors that may influence shedding of pathogenic bacteria, such as grazing endophyte-infected fescue, in cattle is necessary to decrease the incidence of bacteria-related illnesses in both cattle and the possible transmission of these bacteria to humans.

Literature Cited

Fig. 1. Incidence of *E. coli* O157:H7 shedding in cows and calves grazing endophyte-infected (E+) or non-infected (E-) tall fescue. a,b P < 0.05; c,d P = 0.11.

Fig. 2. Incidence of *Salmonella* shedding in cows and calves grazing endophyte-infected (E+) or non-infected (E-) tall fescue (P > 0.10).