

Botanical Composition of Beef Cow Diets Shifts When Native Range Infested with Sericea Lespedeza (*Lespedeza cuneata*) is Supplemented with Corn Steep Liquor

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Introduction

Over 600,000 acres of grasslands in Kansas are infested with the noxious weed sericea lespedeza. Herbicide treatment of sericea lespedeza is expensive; moreover, grassland acreage affected by the weed increased more than 60-fold between 1988 and 2000 despite routine use of herbicide during that period.

Increased grazing pressure on sericea lespedeza by beef cattle may slow the weed's spread and facilitate a measure of biological control. Nutrient composition of sericea lespedeza appears favorable for livestock production, but elevated condensed-tannin content strongly deters voluntary consumption of sericea lespedeza by beef cattle. Feedstuffs with tannin-binding properties may promote voluntary consumption of sericea lespedeza by beef cattle. Confined beef steers fed polyethylene glycol ate more sericea lespedeza than steers not fed polyethylene glycol; however, use of polyethylene glycol as an anti-tannin feedstuff is cost-prohibitive and disallowed from a regulatory standpoint in the United States. Moderate amounts of supplemental corn steep liquor (1.3 to 4 lb/day) have been reported to normalize dry matter intake and protein digestion by confined beef cows fed prairie hay contaminated with sericea lespedeza. In addition, beef cows supplemented with corn steep liquor did not discriminate between sericea lespedeza-contaminated and sericea lespedeza-free prairie hay in a preference trial. An inexpensive and palatable byproduct of corn wet-milling, corn steep liquor is Generally Recognized as Safe (GRAS) by the U.S. Food and Drug Administration when used as a feedstuff for cattle.

Corn steep liquor supplementation indicated that a higher percentage of sericea lespedeza plants were defoliated in pastures grazed by corn steep liquor-supplemented cows than in pastures grazed by unsupplemented cows; however, it was unknown if defoliation was related directly to grazing activity of cows. Therefore, our objective was to evaluate the effects of supplemental corn steep liquor on botanical composition of the diets of beef cows grazing native tallgrass rangeland infested with sericea lespedeza in the Kansas Flint Hills.

Experimental Procedures

Our study was conducted from May 1 through October 1, 2011, in Chautauqua County, KS, on nine native tallgrass pastures located approximately 10 miles southeast of Sedan. Pastures were burned April 10. Plant-species composition of pastures was estimated immediately before initiation of the trial using a modified step-point technique. Frequently occurring graminoids included big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), sedges (*Carex* spp.), and indiagrass (*Sorghastrum*

nutans). Frequently occurring forbs included ragweeds (*Ambrosia* spp.), grassleaf gold-rod (*Euthamia graminifolia*), and sericea lespedeza (*Lespedeza cuneata*).

Nine pastures (124 ± 42 acres each) infested heavily with sericea lespedeza were assigned randomly to one of two grazing treatments consisting of unsupplemented cow-calf pairs or cow-calf pairs supplemented with corn steep liquor (45% dry matter; 34.4% crude protein). All pastures were stocked at 1.2 acres/animal unit months (AUM), a rate typical of the Kansas Flint Hills. Cow-calf pairs were fed supplemental corn steep liquor that was delivered three times per week in portable feed bunks (2 linear feet of bunk space per cow) beginning on June 1. Corn steep liquor was fed to achieve an average intake of 1.0 gallon per cow-calf pair daily (approximately 4 lb dry matter per pair daily).

Lactating, crossbred beef cows with calves ($n = 145$; initial cow body weight = $1,276 \pm 201$ lb) were blocked by age and calving date and assigned randomly to treatments and to pastures. Cow-calf pairs were allowed to graze assigned pastures freely from May 1 through October 1. Cows were exposed to natural-service breeding from May 1 through July 15. Calves were weaned September 1 at an approximate age of 200 days. Cow pregnancy rates were determined by rectal palpation 75 days after bulls were removed from pastures.

Beef cows were gathered on the first of each month from June through October, individually restrained in a squeeze chute (~ 2 min), and fresh fecal-grab samples were collected from each animal. Each sample was hand-mixed to ensure homogeneity and a 0.1-lb subsample was retained for analysis. Grab samples were sealed in plastic containers, immediately placed on ice, and transported to Kansas State University. Samples were stored frozen until microhistological analyses were performed.

Wet fecal samples were soaked overnight in 50% ethanol (v/v). After soaking, ethanol was decanted and samples were homogenized and washed with deionized water through a No. 200 US-standard sieve. Samples were then re-homogenized, strained, and dried in a forced air-oven for 96 hours at 122°F. Dried samples were ground (#4 Wiley Mill, Thomas Scientific, Swedesboro, NJ) to pass a 0.12-in. screen and stored in plastic bags for slide preparation (Bennett et al., 1999)¹.

Dried fecal samples were cleaned, decolorized, and mounted on microscope slides. Slides were evaluated with a compound microscope at 10-fold magnification. The microscope was equipped with a digital camera, and each slide field was photographed for comparison with standard slides. Twenty random fields per slide were selected from the entire slide and used to measure the frequency with which plant fragments appeared. Individual plant species were identified according to their histological characteristics using standard slides for comparison. Due to histological similarities, big bluestem and little bluestem were grouped together for purposes of analysis. Plant fragment prevalence in slide fields was assumed to be equivalent to prevalence in fecal samples and equivalent to the botanical composition (percentage of each plant) of diets grazed

¹ Bennett L. L., A. C. Hammond, M. J. Williams, C. C. Chase Jr., and W. E. Kunkle. 1999. Diet selection by steers using microhistological and stable carbon isotope ratio analyses. *J. Anim. Sci.* 77:2252–2258.

by beef cows. Plant fragments that were not among the 11 range-plant species for which standards were prepared were classified as either unknown grass or unknown forb.

Whole-plant sericea samples were collected from each pasture (40 plants/pasture) on the first day of each month from June through October. Stems were clipped 0.4 in. above the soil surface and sun-dried at the collection site for subsequent analysis of condensed tannins and condensed tannin protein-binding capacity. At the laboratory, sericea lespedeza stems were dried in a forced-air oven (96 hours; 122°F), weighed, ground (#4 Wiley Mill) to pass a 0.04-in. screen, and composited within collection date.

Tannins were extracted using a methanol extraction procedure. Samples were combined with 50% methanol (volume/volume), agitated in an ultrasonicator (Blackstone Ultrasonics, Sheffield, PA) for two 10-minute periods, then centrifuged at $3,000 \times g$ (39°F) for 15 minutes to remove solids. The supernatant was removed and used for further analysis. Condensed tannin concentrations were measured using a modified butanol-HCl reaction. Reaction mixtures were read at 550 nm using a UV spectrophotometer equipped with Gen5 software (Biotech Inc., Winooski, VT). Absorbance was adjusted to CT concentration using leucocyanidin as a standard.

Protein-precipitable phenolics were determined through a reaction between ferric chloride and tannin phenolics. This reaction produced a pink chromophore that could be read spectrophotometrically. Absorbance was measured at 510 nm using a UV spectrophotometer equipped with Gen5 software (Biotech Inc.). Concentrations were determined using a standard curve after accounting for the amount of added sodium dodecyl sulfate solution.

Results and Discussion

Concentration of condensed tannin (Table 1) in sericea lespedeza increased ($P < 0.01$) as the grazing season advanced, reaching its peak during the August collection period (Table 1). Thereafter, condensed tannin concentration declined. Protein-binding capacity of condensed tannin in sericea lespedeza generally mirrored condensed tannin concentration, but peak protein-binding capacity occurred one month later (September 1) than peak condensed tannin concentration.

Prevalence of sericea lespedeza in beef cow diets was influenced ($P < 0.01$) by corn steep liquor supplementation and by collection period (Figure 1). Although sericea lespedeza selection by corn steep liquor-supplemented beef cows was numerically greater than that by unsupplemented beef cows at each of the five collection dates, prevalence of sericea lespedeza in beef cow diets was sufficiently variable that no difference ($P \geq 0.55$) between treatments was detected when concentration and protein-binding capacity of condensed tannin were relatively low (June, July, and October sampling days; Table 1). Conversely, corn steep liquor-supplemented cows selected 30 and 49% more sericea lespedeza than unsupplemented cows during the August and September sampling periods ($P < 0.01$). These times corresponded to greatest condensed tannin concentration and condensed tannin protein-binding capacity in sericea lespedeza.

The relative abundance of sericea lespedeza (Figure 1) in the diets of beef cows in our study ranged from a low of 3.5% (unsupplemented cows on September 1) to a high of

7.5% (corn steep liquor–supplemented cows on October 1). We interpreted this to indicate that, under the conditions of our study, sericea lespedeza was an important forb component of the diet in both supplemented and unsupplemented beef cows. The significance of increased voluntary selection of sericea lespedeza by corn steep liquor–supplemented beef cows during August and September is that these months correspond to flowering and seed production by sericea lespedeza in the Kansas Flint Hills. Increased grazing pressure achieved with goats during this interval of time resulted in drastically reduced seed production by sericea lespedeza.

Supplemental corn steep liquor had no influence ($P \geq 0.10$) on voluntary selection of other plant species that were examined in our study; however, there were important temporal differences in selection of various critical grasses and forbs. Displayed preferences for individual forage plants are influenced by animal perceptions of palatability, plant growth form, plant nutrient composition, and animal experience. Moreover, preferences may change dramatically over time in native range production systems due to temporal fluctuations in availability of key species and maturity-driven changes in palatability, growth form, and nutrient content.

Voluntary selection of all grass species (Figure 2) decreased ($P < 0.01$) from June to October. We speculated that selection of these species was inversely related to nutrient content: native tallgrasses tend to have excellent nutrient profiles while vegetative, but quality declines rapidly as plant maturity advances.

Voluntary selection of forbs (Figure 2) increased during the same interval ($P < 0.05$). We speculated that selection of these plants may have increased over time due to increasing availability and high relative forage quality as the grazing season advanced. In general, the magnitude of change in forb selection from the beginning to end of the grazing season was greater than that previously reported. The abnormally warm, dry conditions under which our study was conducted may have influenced availability and quality of forb plants we monitored.

Implications

Supplemental corn steep liquor increased beef cow tolerance for and acceptance of high–condensed tannin sericea lespedeza in a commercial-scale, native-range production system. We concluded that supplemental corn steep liquor allowed for a desirable change in selection preference by beef cows that stemmed from a critical modification of the post-ingestive consequences associated with condensed tannin consumption.

Supplemental corn steep liquor did not influence voluntary selection by beef cows of any other forage-plant species monitored in our study; however, there were noteworthy temporal shifts in selection. We speculated that these shifts in voluntary selection were driven by changes in plant availability, changes in nutrient composition, or both.

Table 1. Effect of harvest date on concentration¹ and protein-binding capacity of condensed tannins in sericea lespedeza

Item	Condensed tannins, %	Protein binding capacity, %
June 1	10.39 ^a	46.2 ^a
July 1	15.11 ^b	45.5 ^a
August 1	19.11 ^d	49.2 ^c
September 1	16.94 ^c	52.3 ^d
October 1	14.54 ^b	47.9 ^b
SEM	0.105	0.15

^{a-d} Within a column, means without a common superscript differ ($P < 0.01$).

¹ Percentage of total phenolic compounds that precipitated proteins.

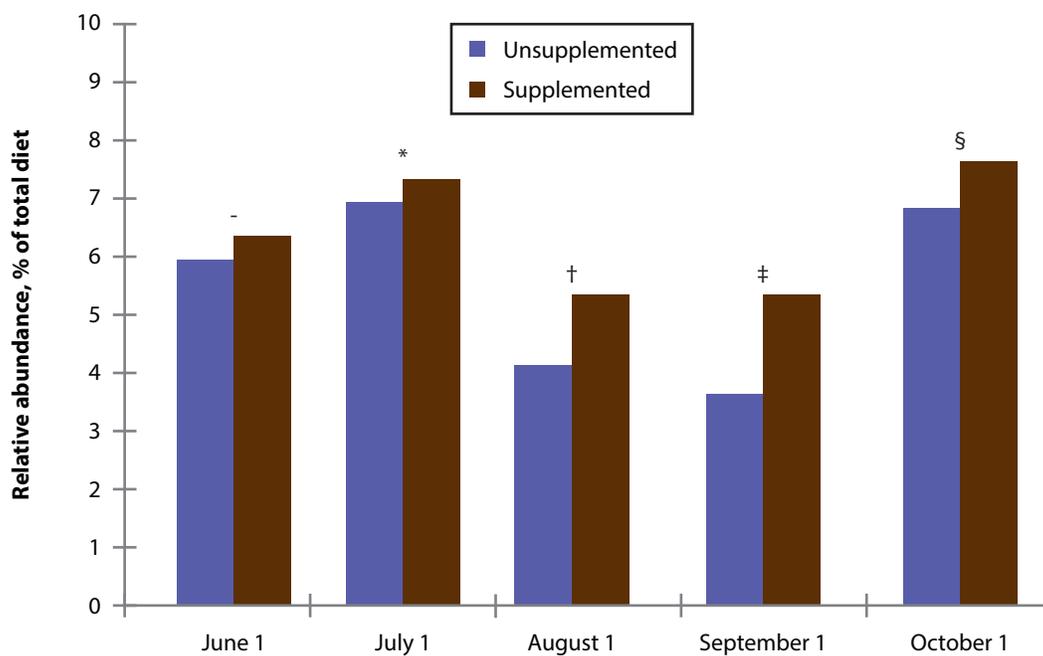


Figure 1. Effects of corn steep liquor supplementation on the relative abundance of sericea lespedeza in diets of beef cows grazing native range in the Kansas Flint Hills.

- Baseline value at beginning of study. Treatments not different; $P > 0.10$.

* July 1 consumption of sericea similar for supplemented and unsupplemented cows; $P = 0.93$.

† August 1 consumption of sericea greater for supplemented than for unsupplemented cows; $P < 0.01$.

‡ September 1 consumption of sericea greater for supplemented than for unsupplemented cows; $P < 0.01$.

§ October 1 consumption of sericea similar for supplemented and unsupplemented cows; $P = 0.35$.

NUTRITION

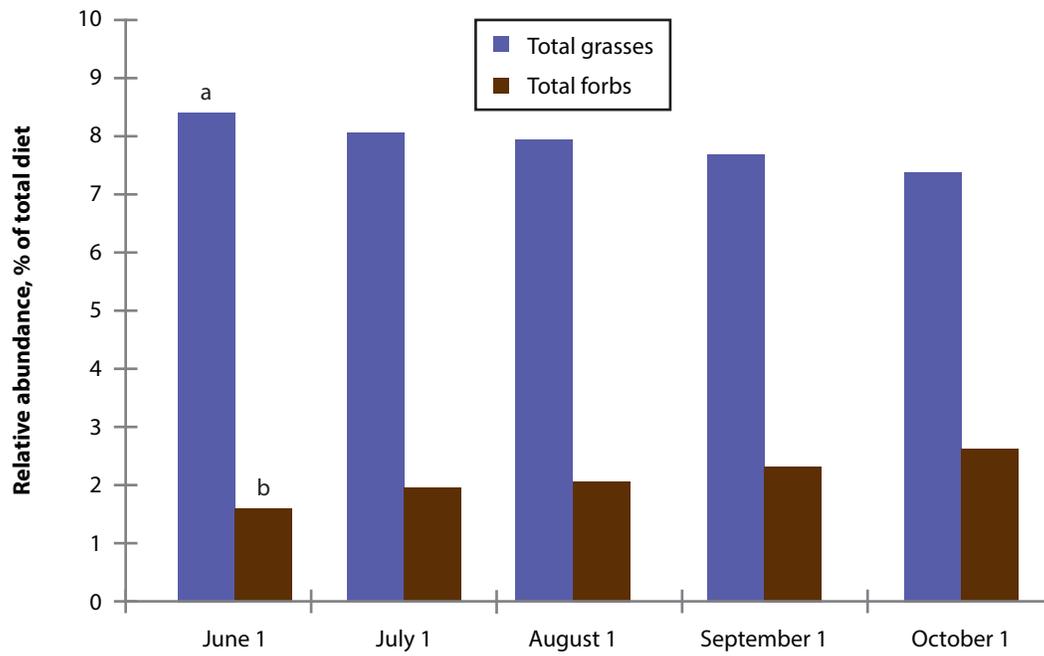


Figure 2. Relative abundance of grasses and forbs in diets of beef cows grazing native range in the Kansas Flint Hills.

^a Effect of time on selection of all graminoid species (quartic, $P < 0.01$).

^b Effect of time on selection of all forb species (quartic, $P < 0.01$).