NITROGEN AND FIBER DIGESTION IN SHEEP FED FRESH-FROZEN AND FIELD-DRIED HIGH- AND LOW-TANNIN SERICEA LESPEDEZA

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ABSTRACT

Field-drying reduces extractable condensed tannin (CT) of sericea lespedeza [*Lespedeza cuneata* (Dum-Cours) G. Don], but effects on specific bound and unbound forms of CT and the relationship to protein and fiber digestion in ruminants are unclear. Intake and digestibility of fresh-frozen and field-dried high- and low-tannin sericea were investigated in a feeding trial with sheep (Ovis spp.). Field-drying had no effect on crude protein (CP) and fiber content of sericea, but shifted CT from extractable to bound forms. Digestion coefficients for CP, neutral detergent fiber (NDF), and acid detergent fiber (ADF) were lower for high-tannin sericea than the low-tannin type. Field-drying had no effect on fiber digestibility but increased CP digestibility and N retention in sheep fed high-tannin forage. Apparent digestion of CT was high for all treatments, but this is likely due to difficulty in analyzing CT in fecal material. Nutritional effects of CT in sericea lespedeza are related to both total CT and proportion of bound and unbound CT in the forage.

KEYWORDS

Sericea lespedeza, condensed tannin, field-drying, digestibility, fiber, nitrogen.

INTRODUCTION

Sericea lespedeza is a warm-season perennial legume that grows well in acid, infertile soils. Common sericea is considered a low-quality forage due to high concentrations of CT and fiber, but improved cultivars with finer stems and lower CT concentrations are now available (Donnelly, 1981). Also, a management tool that can be used to improve digestibility of high-tannin sericea is to field dry the forage for hay. Terrill et al (1989) reported reduced extractable CT concentrations and increased protein and fiber digestibility of field-dried high-tannin sericea compared with fresh-frozen forage. However, due to difficulty in analysis of bound CT in dried forage, the effect of this CT fraction on digestion of sericea lespedeza is poorly understood. Traditionally, CT analysis of forage material has been limited to tannins extractable in organic solvents, leaving bound CT unaccounted for (Terrill et al., 1989; Terrill et al., 1992). Bound CT can represent a large percentage of the total CT in forages, grains, and protein concentrate meals (Terrill et al., 1992) and has been demonstrated to influence digestion of plant material by animals (Bravo et al., 1993). Also, assessing effects of CT on fiber digestion in ruminants is complicated by interference of CT with the detergent system of fiber analysis (Terrill et al., 1994a). The objective of this study was to investigate interrelationships between field-drying, CT, and digestibility in a feeding experiment with sheep fed high- and low-tannin sericea lespedeza using improved methodologies for reducing interference of CT with the detergent system of fiber analysis (Terrill et al., 1994a) and for determination of bound CT in forages (Terrill et al., 1992).

METHODS

Forages. Plots (0.2 ha) of high-tannin (Interstate-76) and low-tannin (74-31-7) sericea lespedeza were established in April 1983 on a Davidson loam soil (clayey, kaolinitic, thermic, Rhodic Kandiudult) at the Central Georgia Branch Station, Eatonton, Georgia, as described by Terrill et al (1989). In June 1986, first-cutting forage was harvested from the plots to 5 cm stubble height, with half the cut forage packed into plastic bags and immediately frozen to -30°C. The other half was field-dried and collected as hay.

Feeding trial. The field-dried and fresh-frozen high- and low-tannin forages were chopped and fed to 4 mature wether sheep (40 - 45 kg) in metabolism crates as described by Terrill et al (1989). The trial was designed as a Latin Square with blocking by period and animal. Forage preservation (field-drying and fresh-freezing) treatments and sericea entries were arranged as a 2 x 2 factorial. In each of 4 periods, sheep were fed the experimental rations in pens for 7 d and then moved to the crates for a 2-day adjustment, followed by a 5 d collection. During the collection period, feed samples were taken at each feeding, and feed refusals, feces and urine were weighed and sampled daily as described by Terrill et al (1989).

Analyses. All feed, feed refusal, and fecal samples were freeze-dried, ground to pass a 1 mm screen in a large Wiley mill, and composited on a weight basis. Composited samples were analyzed for DM (AOAC, 1984), Kjeldahl N (Jones and Case, 1990), NDF, ADF, lignin, and cellulose (Van Soest and Robertson, 1980; Terrill et al., 1994a), and bound and unbound condensed tannins (Terrill et al., 1992). Urine samples were analyzed for Kjeldahl N.

Digestible DM was calculated from DM intake and total daily DM recovered in the feces. Apparent digestibility coefficients for CT, CP, NDF, and ADF were calculated from dietary intake and fecal excretion of these components. Nitrogen balance data were calculated based upon feed, orts, feces and urine data. All data are expressed on a DM basis.

Statistical analyses. Data were analyzed by the statistical analyses system described by SAS (1985) for a 2 x 2 factorial with a 4 x 4 Latin Square arrangement of treatments. Differences between specific mean combinations were determined by contrast statements.

RESULTS AND DISCUSSION

There were no differences in CP and fiber content of the test forages, with average values of 125, 557, 390, 275, and 114 g kg^{-1} for CP, NDF, ADF, cellulose, and lignin, respectively. There was a forage x preservation method treatment interaction for acetone-extractable ($P<0.05$) and protein-bound ($P<0.10$) CT in sericea lespedeza. Field-drying reduced ($P<0.05$) extractable CT concentrations and increased ($P<0.05$) the protein-bound fraction in high-tannin sericea but had no effect on these CT fractions in the low-tannin forage (Table 1). These data support the work of Terrill et al (1989), who reported reduced extractable CT concentrations in field-dried high-tannin sericea lespedeza compared with fresh-frozen forage. These authors did not analyze for bound CT fractions, however. Extractable CT was only 41.9 and 25.6 % of total CT in fresh-frozen and field-dried forage, respectively, in the current study. There was a significant forage effect on total CT concentration in sericea, with higher ($P<0.05$) total CT in Interstate-76 than in 74-31-7 . There was also a preservation method effect, with lower ($P<0.05$) total CT in field-dried than fresh-frozen forages when averaged across sericea entry. These differences may be related to possible leaf loss during collection of sun-cured forages. Leaves of sericea lespedeza are higher in CT than stem tissue (Cope and Burns, 1974).

There was no effect of sericea entry on DM intake, but sheep given fresh-frozen sericea consumed less ($P<0.05$) DM than those fed the field-dried forages (Table 2). This effect may be related to total CT concentrations, which were higher in the fresh-frozen forages, or level of extractable CT, which was highest in the fresh-frozen, high-tannin forage. A negative relationship between extractable CT and intake has been observed previously with sericea lespedeza (Terrill et al., 1989).

Dry matter digestibility of the experimental forages was not affected by preservation method but tended to be lower ($P<0.11$) for the high-tannin than the low-tannin sericea. There was a forage effect on digestibility of CP ($P<0.05$) and NDF ($P<0.06$), with lower values for the high-tannin than low-tannin forages. Negative fiber digestibility coefficients for sheep fed high-tannin sericea may be related to CT effects on the detergent system of fiber analysis. While including sodium sulfite in neutral detergent effectively removes

CT interference with fiber analysis of fresh and dried forages (Terrill et al., 1994a), this step may be less effective at removing CT in fiber residues of fecal material, causing an overestimation of fecal NDF and ADF. The use of this modified fiber analysis system with digesta and feces of animals fed CT-containing forages needs to be further investigated.

There was no preservation method effect on fiber digestibility, but CP digestion coefficients were lower (P<0.06) in fresh-frozen sericea than in the field-dried forages (Table 2). Terrill et al (1989) also reported reduced CP digestibility of fresh-frozen, high-tannin sericea lespedeza compared with field-dried forage.

Due to low recovery of CT in fecal material, apparent digestibility of total CT was high for all the test forages, averaging 907 g kg^{-1}. Terrill et al (1994b) reported low recovery of CT in digesta and feces of sheep fed *Lotus pedunculatus*, a high-tannin legume, using the butanol-HCl bound CT analysis technique. Based upon the quantitative recovery of abomasally-infused ^{14}C-labelled CT in digesta and gut tissues of the small and large intestine of sheep, these authors suggested that poor CT recovery by the butanol-HCl procedure is due to conformational changes in the CT molecule in the gastrointestinal tract so it is no longer reactive with the butanol reagent. Therefore it appears likely that the observed high CT digestibility values in the current investigation are due to difficulty in analyzing CT in feces rather than digestion and absorption of the CT molecule by the animal.

The major effect of CT in sericea lespedeza appears to be on N balance in the animal. Sheep fed high-tannin forages had lower (P<0.05) N intake, higher (P<0.05) fecal and total N excretion, and lower (P<0.05) N retention than sheep fed the low-tannin forage. There was also a preservation method effect on N balance, with reduced (P<0.05) N intake and N retention in sheep fed fresh-frozen sericea compared with the field-dried forages. Individual means were contrasted for N intake and retention to explain these effects. With the fresh-frozen forages, N intake and retention were lower (P<0.05) in sheep fed the high-tannin sericea than those fed the low-tannin type. There was no difference in N intake due to forage type with the field-dried sericea, but N retention was lower (P<0.05) with the high-tannin type. Thus, it appears that the main effect of extractable CT in sericea lespedeza is to reduce intake of fresh forages, whereas the principal effect of a high concentration of bound CT in consumed forages may be increased excretion of fecal N. The nutritional significance of specific bound and unbound CT fractions in forages needs to be further investigated.

Table 1
Condensed tannin concentrations (g kg-1) in field-dried (FD) and fresh-frozen (FF) high- and low-tannin sericea lespedeza.

	High-tannin		Low-tannin		
Item	FD	FF	FD	FF	SEM[a]
Condensed tannin					
Extractable	19[b]	39[c]	9[d]	16[cd]	2.6
Protein-bound	52[b]	43[c]	20[d]	20[d]	2
Fiber-bound	7[e]	5	4	5	0.7
Total	77[f, g]	87	34	41	3.3

[a]Standard error of the mean.
[b, c, d] Row means followed by the same letter are not significantly different (P<0.05).
[e]Differences not significant.
[f] Data pooled across sericea entries differ due to preservation method (P<0.05).
[g]Data pooled across preservation method differ due to sericea entry (P<0.05)

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Table 2
Dry matter intake, digestion coefficients and N balance in sheep fed field-dried (FD) and fresh-frozen (FF) high-and low-tannin sericea lespedeza.

	High-tannin		Low-tannin		
Item	FD	FF	FD	FF	SEM[a]
DM intake (g d^{-1})	1133[b]	873	1167	961	46
Digestion Coefficient (g kg^{-1})					
DM	411[c]	413	452	463	0.2
CP	346[d,e]	252	515	451	33
NDF	86[f]	-107	190	164	80
ADFl	-128[d]	-246	50	36	75
N balance (g d^{-1})					
intake	21.3[b, d]	15.9	21.9	18.1	0.6
Urinary excretion	3.9[g]	4.1	5	5	1
Fecal excretion	13.7[d]	13.0	10.6	9.9	0.7
Total excretion	17.6[d]	17.1	15.5	14.9	0.8
N retained	3.7[b, d]	-1.2	6.3	3.2	0.7

[a]Standard error of the mean.
[d]Data pooled across sericea entries differ due to preservation method (P<0.05).
[c]Data pooled across preservation method differ due to sericea entry (P<0.011)
[d]Data pooled across preservation method differ due to sericea entry (P<0.05).
[e]Data pooled across sericea entries differ due to preservation method (P<0.06).
[f]Data pooled across preservation method differ due to sericea entry (P<0.06).
[g]Differences not significant.