Sheep & Goat Research Journal
Volume 18: 2003

Contents:

Effects of Supplementing Polyethylene Glycol to Goat Kids Grazing Sericea Lespedeza and Early Post-weaning Nutritive Plane Upon Subsequent Growth

Roger C. Merkel[1,3], Arthur L. Goetsch[1] and Nissim Silanikove[2]

Summary

Forty-eight Boer x Spanish doelings (4 mo of age, 20.9 ± 2.35 kg) were used to test effects of polyethylene glycol (PEG) supplementation of grazed sericea lespedeza and early post-weaning nutritive plane and growth rate on subsequent performance with a concentrate-based diet fed in confinement. Treatments were: Barn, with goats kept in individual pens for the 24-wk trial and fed a 70% concentrate diet (17% CP, 69% TDN) free-choice, C, and PS, with two groups of eight doelings per group for each treatment. In the first 6 wk (Phase 1), C and PS groups grazed 0.4-ha lespedeza paddocks (two paddocks and groups per treatment) and were group-supplemented with 88 g/d per animal of concentrate without (C) or with (PS) an additional 25 g/d per animal of PEG. Because of limited rainfall in Phase 1 and the resultant low availability of growing forage, in Phase 2 (6 wk) treatments were changed in a manner thought to increase differences in BW and ADG between C and PS that developed in Phase 1. In Phase 2, C groups resided in two 1-ha paddocks dominated by crabgrass, whereas PS groups grazed two previously ungrazed 1-ha lespedeza paddocks and were supplemented with 1.5% BW of the Barn diet. In Phase 3, the final 12 wk, all doelings consumed ad libitum the 70% concentrate diet in confinement. Phase 1 ADG ranked ($P < 0.05$) Barn > PS > C (154, 95, and 47 g/d, respectively; SE 10.7). ADG in Phase 2 (70, 55, and 57 g/d; SE 9.3), Phase 3 (77, 82, and 72 g/d; SE 8.5), and the whole trial (94, 78, and 62 g/d for Barn, PS, and C, respectively; SE 8.2) were similar among treatments ($P > 0.05$). In conclusion, PEG may have potential to improve ADG by goat kids grazing tannin-containing sericea lespedeza, although testing over a longer period of time is needed. Differences in ADG in the early portion of the grazing period did not affect ADG later when a concentrate-based diet was fed, relative to continuous consumption of the concentrate-based diet.

Key words: sericea lespedeza, goats, daily gain, polyethylene glycol, tannins

Introduction

Sericea lespedeza (*Lespedeza cuneata*) is a perennial summer legume now found throughout Oklahoma and in neighboring states, partly due to its use as a soil conservation crop in the 1930's (Hoveland and Donnelly, 1985). Although sericea lespedeza is a legume and can grow in less fertile soils than other legumes (Young and Eddy, 1998), it is considered a noxious weed in Kansas due to its spread into many pasture areas and the aversion shown it by grazing cattle (Hart et al., 1999). Sericea lespedeza contains condensed tannins that can affect digestibility (Donnelly and Anthony, 1970) and are the likely cause of low consumption by cattle, which limits its usefulness as a pasture forage component for beef. In demonstration trials using goats conducted by the E (Kika) de la Garza American Institute for Goat Research (Hart et al., 1999), no aversion to lespedeza consumption has been noted; thus, lespedeza can be a feedstuff for goat production. However, the problem of condensed tannins and their potential negative effects on digestibility could remain.

Polyethylene glycol (PEG) binds condensed tannins, displacing bound proteins or preventing initial binding (Jones and Mangan, 1977). The ability of PEG to preferentially bind condensed tannins and render them inactive has been extensively used to evaluate effects of condensed tannins in forages on nutrient digestion and absorption, dry matter intake, hormonal influences, and other animal production parameters (Barry and Manley, 1984; Barry et al., 1986 a,b; Waghorn et al., 1994 a,b). Recently, granular PEG has been fed as a supplement mixed with a small amount of grain to goats consuming tanniferous browse species (Silanikove et al., 1996, 1997). Daily dietary PEG administration has improved organic matter intake and average daily gain by Merino ewes fed carob (*Ceratonia siliqua*) leaves (Silanikove et al., 1994).

Common management practices used in rearing goats entail the use of pastures in the early post-weaning phase of growth and possibly later. However, as demand for goat meat increases, the use of concentrate-based finishing diets for goats may become more

1 E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK

2 The Volcani Center, Agricultural Research Organization, Bet Dagan, Israel

3 To whom correspondence should be addressed: E (Kika) de la Garza American Institute for Goat Research, Langston University, PO Box 730, Langston, OK 73050, USA; Phone: 405-466-3836; Fax: 405-466-3138; email: rmerkel@luresext.edu

prevalent. Diets fed in the early post-weaning growth phase have been shown to affect growth rates in subsequent finishing phases in steers (Sainz et al., 1995) and sheep (Goetsch and Aiken, 1999). There has been limited research on this topic using goats. Therefore, objectives of this research were to compare the growth rate of kids grazing sericea lespedeza-dominated pastures in the early post-weaning phase with or without PEG supplementation to that of kids receiving a concentrate diet, and to investigate the effects of early post-weaning growth rate on subsequent performance.

Materials and Methods

Animals and treatments

Forty-eight Boer x Spanish doelings (4 mo of age and avg initial BW of 20.9 ± 2.35 kg) were divided into six groups. Each of the six groups consisted of eight animals. Two groups were assigned to each of three treatments (C, PS, and Barn). The experiment was 24 wk in length, beginning in August. Originally, the experiment was to entail two 12-wk phases. The first phase would compare two grazing treatments to one another and to a confinement treatment. The grazing treatments entailed two different supplements with lespedeza-based pastures. Because it was expected that these Phase 1 treatments would influence growth rate, in Phase 3 a high-quality, concentrate-based diet would be used to determine if the previous treatments and rates of growth in Phase 1 influence later growth with this high-quality diet and little energy being used for activity while in confinement. However, as also noted below, rainfall was quite limited in the first 6 wk, resulting in low availability of growing forage. It was not felt that availability of growing forage would be adequate for normal growth of doelings for much if any of the intended additional 6 wk of lespedeza grazing in Phase 1. Therefore, a decision was made to include a second 6-wk grazing phase (Phase 2) subsequent to the first 6 wk (Phase 1), since it was not felt that only 6 wk of grazing lespedeza with the C and PS treatments would yield differences in performance adequate to potentially influence subsequent growth when in confinement and fed the high-quality diet (12 wk; Phase 3). In Phase 1, there was a considerable difference between grazing treatments in ADG. Hence, since a difference in ADG during grazing was viewed as desirable and in line with objectives of the later confinement/high-quality diet phase (Phase 3), treatments imposed in the second 6-wk grazing phase (Phase 2) were ones intended to increase the magnitude of differences in BW and ADG already realized in Phase 1. Thus, the effect of prior grazing conditions (the sum effect of treatments in Phases 1 and 2) on performance when in confinement and fed the concentrate-based diet in the 12-wk Phase 3 were investigated rather than addressing effects only of treatments in Phases 1 or 2.

In the first 6 wk of the trial (Phase 1), the two C groups grazed two 0.4-ha lespedeza-dominated pastures (approximately 75% cover) and received 85 g/d per animal (DM basis; group-fed) of a corn/soybean meal/mineral mix supplement (Table 1). During that time, the two PS groups grazed identical pastures and in addition to the C supplement, received 25 g/d per animal of PEG. The two Barn groups were individually housed in 1.2 x 1.2 m elevated slatted floor pens and fed a 70% concentrate diet (Table 1) for ad libitum consumption (approximately 120% of consumption on the previous few days) during this and all subsequent phases. The Barn treatment was included to provide a basis for evaluating performance by goats while grazing and thereafter. That is, it was expected that with the high-quality diet, ADG would be greater for Barn vs. C and PS groups in Phases 1 and 2. In accordance, it was anticipated that in Phase 3 ADG would be lowest among treatments for Barn groups. The degrees of difference between the Barn and grazing treatments would provide insight as to the magnitude of growth restriction imparted by grazing in Phases 1 and 2 and of compensatory growth in Phase 3 due to previous grazing treatments.

As noted earlier, the initial experimental design called for C and PS doelings to graze lespedeza for 12 wk. However, low rainfall during the first 6 wk of the experiment led to poor forage growth and the possibility of inadequate growing forage availability in the lespedeza pastures. However, the experimental protocol was modified and a 6-wk Phase 2 was used to maintain a full 12-wk grazing period prior to the 12-wk confinement period. This modification also provided an opportunity to simulate on-farm management decisions whereby producers may or may not provide supplement to animals grazing late-fall pastures. Thus, in Phase 2 the two C groups were moved to two 1-ha crabgrass (*Digitaria spp*.)-dominated pastures and received no supplementation. The two PS groups grazed two previously ungrazed 1-ha lespedeza-dominated pastures and received 1.5% BW of the Barn diet with no additional PEG. It was expected that with consumption of a legume vs. grass and supplementation with the concentrate-based diet, ADG in Phase 2 would be greater for PS vs. C. In the 12-wk confinement period testing effects of previous nutritional plane on subsequent growth (Phase 3), both C and PS groups were moved into individual, slatted floor pens as used for the Barn groups, and all animals received the concentrate-based diet free-choice. Feeding of supplements and the concentrate-based diet was at 0800 h. The C and PS groups totally consumed supplements and the concentrate-based diet fed while on pasture in Phases 1 and 2. For animals in confinement during all phases, feed refusals were removed and weighed prior to feeding. All doelings had free access to water, and C and PS groups also had free access to trace mineralized salt blocks while on pasture. Goats were weighed every 3 wk.

Sampling and laboratory measures

During the second week of Phase 1, forage biomass was estimated using the falling disk meter technique (Bransby et al., 1977). At the same time, an estimation of forage chemical composition was achieved by clipping 10 random 0.08-m^2 areas at an 8-cm height and compositing the clipped forage for one sample per pasture. Additionally, separate samples of lespedeza forage were taken and frozen for subsequent condensed tannin analysis. In Phase 2, pasture biomass was estimated during the second wk by clipping randomly chosen 0.164-m^2 areas per pasture at a height of 2.54 cm and drying the clipped forage in a forced-air oven at 100°C. Then, during week 5 of Phase 2, three mature ruminally fistulated Boer x Spanish wethers became available for use in obtaining a measure of chemical composition of actual consumed forage. Wethers were fasted overnight and the following morning had their rumens emptied

and rinsed with water, and then were allowed to graze for 30 to 40 min. Consumed forage was withdrawn from the rumen and the original ruminal contents were returned. Collected ingesta from all three animals was composited for one sample per pasture. The Barn diet throughout the trial and the grazing supplement in Phase 1 were sampled following mixing.

Samples were initially dried in a 55°C forced-air oven for a minimum of 48 h and then ground to pass a 1-mm screen before analysis. Frozen samples of lespedeza were freeze-dried and ground as oven-dried samples for analysis. Samples of forage, concentrate-based diet and supplement were analyzed for DM (100° C), ash, Kjeldahl N (AOAC, 1990) and NDF (filter bag technique; ANKOM Technology Corp., Fairport, NY). Forage samples underwent additional in vitro DM digestion (filter bag technique, with NDF as the end-point measure; ANKOM Technology Corp.). Freeze-dried samples of lespedeza were analyzed for extractable condensed tannin content following procedures of Terrill et al. (1992) and Dalzell and Kerven (1998).

Statistical analysis

Average daily gain data were analyzed separately for each phase and over the whole trial using General Linear Models procedures of SAS (SAS, 1989), with a model including treatment and using group within treatment as the error term. Thus, animal group rather than individual animal was the experimental unit. Treatment means were separated by least significant differences with a protected F-test.

Results and Discussion

Forage and concentrate

Forage chemical composition was similar between PS and C in both Phases 1 and 2 (Table 2). The greater forage NDF concentration and lower in vitro digestibility in forage samples of Phase 2 vs Phase 1 reflects the increasing maturity of forage as the trial progressed from August to November. Available forage mass was similar between PS and C in Phase 1, whereas the C group had higher available forage mass in Phase 2. The similarity of forage chemical composition and digestibility between PS and C in Phase 2 suggests that the difference in available forage mass did not allow C kids to select a much more nutritious diet than PS doelings, although C animals only consumed pasture forage. Condensed tannin content of lespedeza was similar between C and PS pastures. The level of extractable condensed tannins reported here is higher than that reported by Terrill et al. (1990) of 12.7% for lespedeza harvested in August. Condensed tannin levels in sericea lespedeza have been reported to increase due to increased environmental temperatures, decreased rainfall and increased maturity (Donnelly, 1959; Cope and Burns, 1974). Lespedeza harvested during this study was collected in September after a period of low rainfall and high temperature.

Average daily gain and compensatory growth

Phase 1 ADG ranked ($P < 0.05$) Barn > PS > C (Table 3). However, ADG in Phases 2 and 3 were similar among treatments ($P > 0.05$). Overall ADG was greater ($P < 0.05$) for Barn vs. C. In Phase 1, greater ADG for doelings supplemented with PEG compared with C may be attributable to binding of sericea lespedeza condensed tannins by PEG and improved lespedeza digestibility. In addition to binding dietary protein, polyphenolic constituents of condensed tannins can react with microbial cell walls and the extracellular enzymes they secrete, resulting in decreased viability of ruminal microbes and digestibility of cell wall carbohydrates (Reed, 1986; McSweeney et al., 2001). PEG supplementation has proven beneficial in improving diet digestibility and growth in goats (Silanikove et al., 1996) and sheep (Silanikove et al., 1994) consuming tanniferous browse species. The results of the present trial suggest that PEG supplementation could be a useful tool to enhance performance of goats grazing sericea lespedeza and other tannin-containing forages. However, these results were obtained only over a 6-wk period, suggesting need for further study with longer periods of grazing and supplementation.

As noted before, it was anticipated that the nutritional plane for PS goats would be greater than that for C in Phase 2, thus eliciting greater ADG. Moreover, Phase 2 was intended to increase differences in potential for compensatory growth in Phase 3. However, during Phase 2 when no PEG was fed, ADG of PS animals fell to a level similar to that of C goats, despite the fact that PS doelings were supplemented with 1.5% BW of the concentrate-based diet. It was expected that lespedeza and condensed tannin intake would be less in Phase 2 vs. 1 because of supplementation with the concentrate-based diet. However, it is possible that the level of condensed tannins consumed in Phase 2, without PEG supplementation, may have been great enough to adversely affect performance. It is unclear why ADG of Barn groups in Phases 2 and 3 were much lower than in Phase 1. It is possible that the high ADG for Barn groups during Phase 1 may have been due to compensatory growth because of pasture grazing prior to the beginning of this experiment.

The similarity in ADG among treatments in Phases 2 and 3 despite substantial differences in Phase 1 reflects an absence of compensatory growth. Conversely, Wuliji et al. (2001) observed considerable compensatory growth by Spanish wethers when fed a concentrate-based diet or dehydrated alfalfa pellets following a 9-wk period with consumption of prairie hay supplemented with soybean meal and little change in BW. Results of these experiments could indicate that compensatory growth in goats is not likely with moderate ADG. However, separation of Phases 1 and 3 by the 6-wk Phase 2 with similar ADG among treatments could have also impacted potential for compensatory growth by C and PS doelings in response to the high nutritional plane in Phase 3.

Conclusions

PEG supplementation of Boer x Spanish doelings grazing condensed tanning-containing sericea lespedeza-dominated pastures resulted in a doubling of ADG compared with doelings not receiving PEG in a 6-wk grazing period. Hence, PEG supplementation could be a valuable tool in the management of meat goats grazing tanning-containing forage to increase growth rate. However, future studies should entail longer periods of evaluation. Differences in ADG in the early post-weaning period did not affect ADG later with the feeding of a concentrate-based diet relative to continuous concentrate consumption, perhaps because ADG in the limiting nutritional

plane phase was moderate and(or) periods of low and high nutritional planes were not consecutive.

Acknowledgment

This research was supported by USDA Project Number 9703145.

Literature Cited

AOAC, 1990. Official Methods of Analysis. 14th Edition. Association of Official Analytical Chemists, Washington, DC.

Barry, T.N. and T.R. Manley. 1984. The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep. 2. Quantitative digestion of carbohydrates and proteins. Br. J. Nutr. 51:493-504.

Barry, T.N., T.F. Allsop and C. Redekopp. 1986a. The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep. 5. Effects on the endocrine system and on adipose tissue metabolism. Br. J. Nutr. 56:607-614.

Barry, T.N., T.R. Manley and S.J. Duncan. 1986b. The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep. Br. J. Nut. 55:123-137.

Cope, W.A. and J.C. Burns. 1974. Components of forage quality in sericea lespedeza in relationship to strain, season, and cutting treatments. Agron. J. 66:389-394.

Dalzell, S.A. and G.L. Kerven. 1998. A rapid method for measurement of *Leucaena* spp proanthocyanidins by the proanthocyanidin (Butanol/HCL) assay. J. Sci. Food Agric. 78:405-416.

Donnelly, E.D. 1959. The effect of season, plant maturity, and height on the tannin content of sericea lespedeza, *L. cuneata*. Agron. J. 51:72-73.

Donnelly, E.D. and W.B. Anthony. 1970. Effect of genotype and tannin on dry matter digestibility in sericea lespedeza. Crop Sci. 10:200-202.

Goetsch, A. L., and G. E. Aiken. 1999. Effects of limited concentrate intake following forage on subsequent performance of lambs consuming concentrate. Sheep Goat Res. J. 15:147-153.

Hart, S., J. Mayo, D. Rogers, N. Escobar, T. Eddy, and J. Young. 1999. Using goats to control the invasion of Sericea lespedeza in the Kansas Flint Hills grasslands. In: Proceedings of the Goat Field Day. pp 121-122. Langston University, Langston, OK.

Hoveland, C.S. and E.D. Donnelly. 1985. The lespedezas. In: M.E. Heath, R.F. Barnes and D.S. Metcalfe (eds.). Forages: The Science of Grassland Agriculture. Iowa State University Press, Ames, IA. Pp. 128-135.

Jones, W.T. and J.L. Mangan. 1977. Complexes of the condensed tannins of sainfoin (*Onobrychis viciifolia* Scop.) with Fraction 1 leaf protein and with submaxillary mucoprotein, and their reversal by polyethyleneglycol and pH. J. Sci. Food Agric. 28:126-136.

McSweeney, C.S., B. Palmer, D.M. McNeil and D.O. Krause. 2001. Microbial interactions with tannins: nutritional consequences for ruminants. Anim. Feed Sci. Tech. 91:83-93.

Reed, J., 1986. Relationships among soluble phenolics, insoluble proanthocyanidins and fiber in East African browse species. J. Range Mgt. 39:5-7.

Sainz, R. D., F. De La Torre, and J. W. Oltjen. 1995. Compensatory growth and carcass quality in growth-restricted and refed beef steers. J. Anim. Sci. 73:2971-2979.

SAS. 1989. SAS User's Guide, Version 6, 4th Edn., Vol. 2. SAS Inst. Inc., Cary, NC.

Silanikove, N., N. Gilboa, and Z. Nitsan. 1997. Interactions among tannins, supplementation and polyethylene glycol in goats given oak leaves: effects on digestion and food intake. Anim. Sci. 64:479-483.

Silanikove, N., N. Gilboa, I. Nir, A. Perevolotsky, and Z. Nitsan. 1996. Effect of a daily supplementation of polyethylene glycol on intake and digestion of tannin-containing leaves (*Quercus calliprinos*, *Pistacia lentiscus*, and *Ceratonia siliqua*) by goats. J. Agric. Food Chem. 44:199-205.

Silanikove, N., Z. Nitsan, and A. Perevolotsky. 1994. Effect of a daily supplementation of polyethylene glycol on intake and digestion of tannin-containing leaves (*Ceratonia siliqua*) by sheep. J. Agric. Food Chem. 42:2844-2847.

Terrill, T.H., A.M. Rowan, G.B. Douglas and T.N. Barry. 1992. Determination of extractable and bound condensed tannin concentrations in forage plants, protein concentrate meals and cereal grains. J. Sci. Food Agric. 58:321-329.

Terrill, T.H., W.R. Windham, J.J. Evans and C.S. Hoveland. 1990. Condensed tannin concentration in sericea lespedeza as influenced by preservation method. Crop Sci. 30:219-224.

Waghorn, G.C., I.D. Shelton and W.C. McNabb. 1994a. Effects of condensed tannins in *Lotus pedunculatus* on its nutritive value for sheep. 1. Non-nitrogenous aspects. J. Agric. Sci. (Cambridge) 123:99-107.

Waghorn, G.C., I.D. Shelton and W.C. McNabb. 1994b. Effects of condensed tannins in *Lotus pedunculatus* on its nutritive value for sheep. 2. Nitrogenous aspects. J. Agric. Sci. (Cambridge) 123:109-119.

Wuliji, T., A. L. Goetsch, R. Puchala, S. Soto-Navarro, R. C. Merkel, G. Detweiler, T. Gipson, and T. Sahlu. 2001. Feed intake, digestibility, and growth of Spanish kids consuming different quality diets. J. Anim. Sci. 79(Suppl. 1):414 (Abstr.).

Young, J., and T. Eddy. 1998. Biology of Sericea. Kansas Biology Teacher 7(2):73.

Table 1. Composition of the concentrate-based diet (Barn) and supplements given during grazing of sericea lespedeza (C and PS) for Boer x Spanish doelings

Ingredient	Barn	C	PS
	% DM		
Cottonseed hulls	30.0	0.0	0.0
Corn	48.4	49.5	38.0
Soybean meal	9.1	24.8	19.0
Blood meal	1.72	0.0	0.0
Fish meal	2.30	0.0	0.0
Feather meal	1.72	0.0	0.0
Dried molasses	3.0	0.0	0.0
Dicalcium phosphate	0.07	5.06	3.8
Limestone	1.18	5.06	3.8
Vitamin premix[1]	0.5	7.6	5.7
Trace mineral salt[2]	0.66	7.6	5.7
Ammonium chloride	0.75	0.0	0.0
Deccox[3]	0.05	0.0	0.0
$NaSO_4$	0.3	0.0	0.0
Salt	0.25	0.0	0.0
Polyethylene glycol	0.0	0.0	23.75
Rumensin	0.0	0.38	0.25

[1]Contained 2200 IU vitamin A, 1200 IU vitamin D_3, and 2.2 IU vitamin E per gram.
[2]Contained 95 to 98.5% NaCl and at least 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.011% Co, 0.007% I, and 0.005% Zn.
[3]Rhône-Poulenc, Inc., Atlanta, Ga; 6% decoquinate.

Table 2. Composition of the concentrate-based diet (Barn) and supplements given during grazing (polyethylene glycol [PS] and C) and of available forage for Boer x Spanish doelings

	Phase 1[1]				Phase 2[2]			Phase 3[3]
	Diet/supplement		Forage[4]		Diet	Forage[4]		Diet
Item	Barn	PS/C	PS	C	Barn	PS	C	Barn
OM, %	92.7	75.9	94.2	94.6	93.7	89.5	89.5	94.0
CP, %	16.9	13.8	8.8	8.1	15.6	9.4	8.8	15.0
NDF, %	21.2	9.9	36.8	39.3	36.3	66.4	68.5	35.3
Condensed tannin, %	-	-	17.0	17.2	-	-	-	-
In vitro DM digestion[5], %	-	-	70.7	69.1	-	58.4	56.0	-
Forage mass[6], kg/ha	-	-	2804	2697	-	2372	3119	-

[1]Phase 1 (6 wk): Barn = concentrate-based diet given free-choice in individual pens; PS and C = grazing lespedeza-dominated pastures and receiving a concentrate supplement with or without 25g/d PEG.
[2]Phase 2 (6 wk): Barn = same as in Phase 1; PS = grazing previously ungrazed lespedeza-dominated pastures and receiving 1.5% BW of the concentrate-based diet; C = grazing crabgrass-dominated pastures without receiving supplementation.
[3]Phase 3 (12 wk): all animals fed the concentrate-based diet free-choice in individual pens.
[4]Phase 1: random samples of pasture forage cut at 2.54-cm height; Phase 2: samples of consumed forage taken using three ruminally fistulated wethers.
[5]Filter bag technique with NDF as the end-point measure.
[6]Phase 1: estimated using falling disk meter technique; Phase 2: random samples of 0.167-m^2, 10 per pasture, cut at 2.54-cm height, and dried for DM determination.

Table 3. Average daily gain for Boer x Spanish doelings

	Treatment			
Phase[1,2,3]	Barn	PS	C	SE
	g/d			
1	154[a]	95[b]	47[c]	10.7
2	70	55	57	9.3
3	77	82	72	8.5
Whole trial	94[a]	78[ab]	62[b]	8.2

[1]Phase 1 (6 wk): Barn = concentrate-based diet given free-choice in individual pens; polyethylene glycol [PS] and C = grazing lespedeza-dominated pastures and receiving a concentrate supplement with or without 25g/d PEG.
[2]Phase 2 (6 wk): Barn = same as in Phase 1; PS = grazing previously ungrazed lespedeza-dominated pastures and receiving 1.5% BW of the concentrate-based diet; C = grazing crabgrass-dominated pastures without receiving supplementation.
[3]Phase 3 (12 wk): all animals fed the concentrate-based diet free-choice in individual pens.
[a, b, c] Unlike superscripts within phase differ ($P < 0.05$).