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Research Paper

Does initial body condition affect wether kid feed intake and performance when fed alfalfa or *Lespedeza cuneata* L.?

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ABSTRACT

Legumes with excessive condensed tannins may become unpalatable to ruminants; however, body condition may affect feed intake. Our objective was to evaluate the performance of goats with different initial bodies condition scores fed pellets composed of pure alfalfa, sericea lespedeza, and this with polyethylene glycol (PEG) for 35 days. Goats had compensatory gain, once no difference ($P > 0.05$) among body scores was obtained in final body weight. Goats in low body scores had greater ($P \leq 0.05$) average daily gain. About feed intake, no differences among legume diets were found in the high diet group. In most of the variables, animals in the high group kept greater their body measures, as well as legumes could be similar ($P > 0.05$), despite of SL quality. Pellets made from sericea and plus PEG decreased ($P \leq 0.05$) gases productions. Goats in low body conditions have compensatory gain when fed either sericea or plus PEG, both viable substitutes for alfalfa. Body measurements are a tool to predict body weight, in spite of moderate correlations. Pellets made from sericea can decrease feed energy loss via CH_4 emissions and provide an alternative N pathway.

1. Introduction

Condensed tannins (CT) are phenolic compounds thought to protect plants through astringency which inhibits ruminant intake and performance, depending on concentration, type and molecular mass (Naumann et al., 2014). Thus, forages can become unpalatable to ruminants with excessive dietary CT which negatively affects feed intake; we do not know, however, whether body condition score (BCS) and compensatory gain-driven appetite affects this plant-animal interaction. Compensatory gain after long periods ingesting high-CT diets may occur. This interaction may be further complicated for goats that may find high-CT feed more palatable than species such as cattle or sheep that consider plant secondary compounds less tolerable (Van Soest, 1994; Takano et al., 2007; Lamy et al., 2011).

Browse containing CT can alter digestibility and methane (CH_4) emission when consumed at 20–120 g kg^{-1} dry matter (DM) (Huang et al., 2010; Hart et al., 2011; Naumann et al., 2013). Above those levels, ruminants may suffer negative nutritional consequences because of the strong linkage with enzymes, metal ions and carbohydrates (Reed, 1995; Pagán-Riestra et al., 2010; Armstrong et al., 2013) although some browsers can neutralize CT via salivary proline (Mole et al., 1990).

Lespedeza cuneata (Dum. Cours.) G. Don (sericea lespedeza, SL), a productive and persistent perennial herbaceous legume, is grown throughout the subtropics as a forage (Muir et al., 2014) and may become a commercial source of herbage-CT to decrease gastro-intestinal nematode infections and rumen CH_4 emission (Lange et al., 2006; Muir, 2011; Naumann et al., 2013). It can be fed directly as pasture (Min et al., 2005), hay (Shaik et al., 2004) or as pellets (Terrill et al., 2007). However, PEG is a polymer that binds to CT, reducing its biological properties (Ben Salem et al., 2000; Ndagurwa and Dube, 2013; Mantz et al., 2009).

The objective of our study was to evaluate the performance of goats with different initial BCS fed pellets composed of only *Medicago sativa* L. (alfalfa, ALF) and SL, or SL plus PEG.

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2. Material and methods

2.1. Diets and animal pre-conditioning

The trial was performed at Stephenville Texas A & M AgriLife Research Center, Texas, USA, where SL was grown, hayed and pelletized with 10% water and 3% binder (lignin) to avoid selective feeding by the kids. In a separate pellet batch, PEG was added to SL, water and binder in 1:1 ratio of PEG:CT. Spanish wether kid goats (4–6 mo old, averaging 19.6 ± 1.2 kg) were purchased from a local farmer.

Goats were dewormed with 1 cc orally per 5 kg of Cydectin® (Boehringer Ingelheim, 1 mg moxidectin ml^{-1}) and pre-conditioned during 30 days in pens to bring them to body condition scores 2, 3 or 4 (Keith et al., 2009). In order to have animals in the required BCS, the 12 wethers at BCS 2 were fed low-protein (8%) bermudagrass hay in controlled quantities that should have induce 60 g animal daily gain (ADG). The 12 wethers that were to attain BCS 3 were fed bermudagrass hay and commercial pellets (160 g kg^{-1} crude protein (CP), 220 g kg^{-1} crude fiber and 30 g kg^{-1} crude fat) at 11% CP at controlled amounts that would induce 125 g ADG. The 12 to attain a BCS of 4 were fed bermudagrass hay *ad libitum* and commercial pellets at 14% CP predicted to induce 250 g ADG.

2.2. Feed trial

After pre-conditioning, during the actual feeding trial period, all 36 wethers were placed in individual feeding pens measuring 16.25 m^2 provided with water, mineral salt and partial shade. For 35 days, four wethers from each BCS group were offered ALF, SL or SLP up to 7%, DM basis, of wether body weight (BW).

2.3. Body measurements

Variables measured included ADG (final BW minus beginning BW divided by 35 days), BCS, feed intake, thoracic girth (TG), body length (BL), as well as wither height (WH) and ramp height (RH). Feed intake was measured every week by collecting refusals which were oven-dried at 55 °C for 72 h, weighed, and subtracted from the pellet weights fed that individual during that week. Body condition scoring was based on a scale ranging from 1 (very thin; visible ribs, spinous and transverse process) to 5 (obese; backbone and ribs fatted, spinous-transverse process lost and bulged) as described by Keith et al. (2009). Linear body measurements were taken according to Cam et al. (2010). Around the chest behind the front leg insertion TG was measured. The vertical distance from the top of the scapula to the platform was considered the WH. Pelvic girdle top to the platform comprised RH. The distance from the sternum to the aitch bone was considered the BL.

2.4. Feed chemical composition

Feed chemical composition (Table 1) were analyzed at the Texas A & M AgriLife Research herbage laboratory at Stephenville, Texas USA. At the Animal Nutrition Laboratory, North Florida Research and Education Center, University of Florida, USA we analyzed volatile fatty acids (VFA), CH_4, and ammonia nitrogen ($N{-}NH_3$) contents.

According to AOAC (1990, N930.04), DM content was estimated. Vario MACRO C—N Analyzer (Elementar Americas, Inc., Mt. Laurel, NJ, USA) estimated N, which was converted to CP by multiplying by 6.25. The neutral (NDF) and acid detergent fiber (ADF) were determined according to methods described by Van Soest (1967) in an ANKOM™ Fiber Analyzer (ANKOM Technology Corp., Fairport, NY, USA). Purification and quantification of CT in SL was based on the species-specific standard curve (Wolfe et al., 2008). Analyses of protein precipitable phenolics (PPP) were estimated as described by Naumann et al. (2014) in three replicated crude extracts of plants.

Table 1
Feed chemical composition, on dry matter (DM) basis.

Items	Legumes pellets		
	Alfalfa	Sericea lespedeza	Sericea lespedeza + PEG[a]
DM, g kg^{-1}	936	947	949
CP, g kg^{-1}	191	103	98.2
NDF, g kg^{-1}	509	548	522
ADF, g kg^{-1}	375	390	380
NFC, g kg^{-1}	200	229	252
PPP[b], g kg^{-1}	–	47.7	47.7
TDN, g kg^{-1}	580	590	590
NEL, Mcal kg^{-1}	0.58	0.56	0.58
NEM, Mcal kg^{-1}	0.54	0.54	0.55
NEG, Mcal kg^{-1}	0.28	0.29	0.30

[a] PEG, polyethylene glycol; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; NFC, non-fiber carbohydrates; PPP, protein precipitable phenolics; TDN, total digestible nutrients; NEL, net energy for lactation; NEM, net energy for maintenance; NEG, net energy for gain.
[b] Before pelletizing.

2.5. In vitro assays

For *in vitro* incubations, rumen fluid was collected from two ruminally cannulated Angus crossbred steers (291 ± 22.6 kg of BW). The steers were consuming bahiagrass hay *ad libitum* and received 2 kg of a 50:50 molasses:glycerol mix for at least 2 weeks before the rumen fluid collection. Ruminal fluid was placed in a pre-warmed thermos container, strained from a sample of digesta through cheese cloth, and transported immediately to the laboratory. Each replicate day, 125-mL serum bottles and 100-mL tubes containing 0.7 g of substrate as is (approx. 0.61 g of DM) and 50-mL of incubation fluid each were incubated for 48 h at 39 °C under constant oscillation at 60 rpm. The inoculum was comprised of a 3:1 mixture of McDougall's buffer and rumen fluid. After purging with CO_2, bottles were capped with butyl stoppers, crimp-sealed with aluminum caps, and placed in an incubation bath at 39.1 °C with continuous shaking at 40 oscillations/min. At the end of the 48-h incubation period, serum bottles were placed for 15 min in an ice bath to stop the fermentation and were then allowed to reach room temperature for a minimum of 15 min before the beginning of the gas production measurements. At 48 h, gas volume was measured by water displacement in an inverted burette as described by Kung et al. (2000).

At the end of the incubation period, VFA were measured along with $N{-}NH_3$, final pH, CH_4 production, and *in vitro* organic matter digestibility (IVOMD). Fermentation was stopped by adding 1-mL of a 20% H_2SO_4 solution to each bottle at the end of the incubation. Then, a 10-mL sample was taken and frozen for subsequent VFA and $N{-}NH_3$ analyses.

Total gases produced were determined by measuring water displacement. A 14-gauge needle connected to a 250-mL inverted buret was used to puncture the butyl-rubber stopper of each 125-mL bottle, and gas production was calculated by measuring the milliliters of water displaced. After the pressure was released, 10-mL gas samples were taken from the headspace of the bottles using a 14-gauge needle connected to a 2-way valve on a syringe. Once the samples were taken, the valves were closed, and the needles removed from the 125-mL serum bottles. The 10-mL gas samples were used to measure CH_4 concentration by gas chromatography (Agilent 7820A, Agilent Technologies Santa Clara, CA) using a capillary column (Plot Fused Silica 25 m × 0.32 mm, Coating Molsieve, 5A Varian CP7536).

Concentrations of $N{-}NH_3$ in the incubation fluid were measured after centrifuging at 10,000 x *g* for 15 min at 4 °C (Avanti J-E, Beckman Coulter Inc., Palo Alto, CA) following the phenol-hypochlorite technique described by Broderick and Kang (1980). Flat-bottom 96-well plates and a plate reader (DU-500, Beckman Coulter Inc., Brea CA USA)