The Professional Animal Scientist 28 (2012):528–533

Effect of dietary protein level and quebracho tannin on consumption of pine needles (*Pinus ponderosa*) by beef cows

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ABSTRACT

Ponderosa pine trees occupy over 15 million hectares of rangeland in western North America. Pregnant cows often consume pine needles (PN), and subsequently abort. The protein-to-energy ratio may be important in the ability of cattle to tolerate dietary terpenes. Tannins often co-occur with terpenes and may also influence diet selection. The objective of this experiment was to determine if the protein-to-energy ratio or the addition of quebracho tannin to cattle diets would influence PN consumption. In trial 1, 15 cows in moderate body condition were assigned to high (15.4% CP), medium (10.2% CP), or low (4.9% CP) dietary protein treatments for 12 d. In trial 2, 15 cows were assigned to high (5%), medium (2.5%), or no (0%) quebracho tannin diets for 8 d. In both trials, green PN were offered at 0930 h for 90 min. There was a treatment effect ($P = 0.05$) and a treatment × day interaction ($P = 0.01$) for PN consumption, as cattle on the high CP treatment consumed more PN than cattle on the medium and low CP diets for 4 and 6 d, respectively. Initially, treatments did not differ ($P > 0.09$), but from d 3 to 9 cattle on the high CP treatment ate more PN than the other treatments. There was a day × treatment interaction ($P = 0.002$) for PN consumption; cattle on the 2.5% tannin treatment consumed less PN than did animals on the other treatments. Cattle are apparently unable to tolerate high quantities of PN terpenes on a low-protein diet. Tannins may influence PN consumption, but the mechanism is unknown.

Key words: cattle, intake, *Pinus ponderosa*, protein status, tannin

INTRODUCTION

Ponderosa pine trees occupy more than 15 million hectares of rangeland in the western United States and Canada. Pregnant cows often consume pine needles when grazing (Pfister and Adams, 1993) and subsequently abort (James et al., 1989). The abortifacient compound in pine needles is a diterpene resin acid, isocupressic acid (Gardner et al., 1994, 1996). Pine needle consumption typically increases if grazing cows are in low body condition (Pfister et al., 2008) or during winter when forage availability is limited by snow cover or lack of forage (Pfister and Adams, 1993; Pfister et al., 1998).

Interactions among nutrients and plant secondary compounds may influence how cattle select diets. Studies suggest that the protein-to-energy ratio may be an important factor in the ability of ruminants to tolerate high levels of terpenes in the diet (Villalba et al., 2002a; Pfister et al., 2008). Protein and energy are both critical for detoxification, and supplementation can improve nutrient balance and allow animals to consume more secondary compounds (Illius and Jessop, 1995; Foley et al., 1999).

Tannins often occur in plants with terpenes and may also influence nutrient absorption and diet selection (Villalba et al., 2002b, 2004) by binding to proteins in the mouth and the rumen, thus reducing protein digestibility (Robbins et al., 1987). Tan-

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nins may interact both with dietary proteins and terpenes (Lyman et al., 2008) to influence dietary selection by herbivores (Baraza et al., 2005). A combination of restricted tannins and ad libitum terpenes in lamb diets enhanced overall food intake (Mote et al., 2007).

The first objective of this experiment was to extend previous work (Pfister et al., 2008) on the influence of dietary protein concentration on pine needle consumption using cattle in moderate body condition. A tannin-containing diet may increase the amount of terpenes consumed by ruminants (Mote et al., 2007), but there is no information available on the influence of tannins on ingestion of terpene-laden ponderosa pine needles by beef cattle. Thus, the second objective of this experiment was to determine if cows given diets of high, medium, and low quebracho tannin (extract from *Schinopsis balansae*) in conjunction with a diet of medium CP would consume differing amounts of pine needles.

MATERIALS AND METHODS

Animals and Feeding

Experiment 1. Fifteen mature (3 yr old; 460 ± 39 kg BW) Hereford × Angus cows that were naive to pine needles were used in the experiment. These animals were raised on treeless rangelands dominated by grasses in northern Utah. Nonpregnant cows were used so that the sequelae of pine needle-induced abortions would not confound these experiments. Cows were in moderate body condition (median score 5.5; 1 = emaciated, 9 = obese) and housed in Logan, Utah, and randomly assigned to either high (15.4% CP), medium (10.2% CP), or low (4.9% CP) treatment groups. All treatment groups were given their respective feeding regimen for 14 d before the trial began. Diet composition is given in Table 1; cattle were given this regimen at 2.5% of BW. All procedures were approved by the Utah State University Institutional Animal Care and Use Committee and were conducted under veterinary supervision.

Experiment 2. The same animals were used in this sequential trial. At the conclusion of Exp. 1, all cows were placed on the medium (10.2%

Table 1. Ingredients and composition of the diets and forages fed to cattle during Exp. 1 (high, medium, and low protein) and Exp. 2 (0, 2.5, and 5% quebracho tannin)[1]

Item	High protein	Medium protein	Low protein	Quebracho tannin[2]	Pine needles
Ingredient, g/kg, DM basis					
Exp. 1					
Beet pulp	130	420	480		
Grape pomace	300	355	425		
Alfalfa hay (good quality)	397.5	110	50		
Soybean meal[3]	140	100	5		
Corn oil	30	15	40		
Urea	2.5	0	0		
Exp. 2					
Beet pulp				370	
Grape pomace				397	
Alfalfa hay (good quality)				110	
Soybean meal 47%				100	
Corn oil				23	
ME,[4] Mcal/kg	2.2	2.18	2.18	2.2	
CP, g/kg	153.7	102.4	54.7	101.9	70
CP/ME ratio, g/Mcal	69.9	47	25		
NDF,[5] g/100 g	47.7	54.4	50.7		55
IVTD,[6] g/100 g	67.5	64.2	67.2		42
ICA concentration,[7] g/100 g	—	—	—		1.15

[1]All ingredients and composition expressed on a DM basis.

[2]The quebracho tannin diets were the same for all treatments except that finely ground wheat straw and tannin (0, 2.5, and 5%) were substituted for one another. Between trials, animals were placed on the medium protein diet for 14 d.

[3]Soybean meal 47% was used in the high and medium protein diets, and soybean 44% was used in the low-protein diet.

[4]ME values based on NRC (2000).

[5]NDF was 49.1, 48.4, and 48.8 g/100 g for the 0, 2.5, and 5% quebracho tannin diets, respectively.

[6]IVTD = in vitro true digestibility. IVTD of the 0, 2.5, and 5% quebracho tannin diets was 66.7, 68.1, and 67.1 g/100 g, respectively.

[7]Isocupressic acid concentration; this diterpene acid, and metabolites thereof, are the abortifacient compounds in ponderosa pine needles.