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ASSESSING THE NUTRITIVE VALUE OF ONE-SEED JUNIPER IN SHEEP

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ABSTRACT: One-seed juniper (*Juniperus monosperma*; **JM**) encroachment on rangelands is a problem in the Southwest. A proposed method of JM control is defoliation by small ruminants. Juniper produces secondary metabolites that may be antimicrobial in nature. Ruminants depend on ruminal microbes for digestion of feed. Five ruminally fistulated wethers (BW 55 ± 15 kg) were used in two cross-over experiments composed of two 20-d periods to estimate nutritive value of JM as a forage. In Exp.1, sheep were fed either 100% buffalo grass straw (*Buchloe dactyloides*; **BS**; 93% DM, 76.5% NDF, 4.5% CP (DM basis)) or a mixed diet of 75% buffalo grass straw and 25% JM (**BS+JM**; JM contained 73% DM, 71.7% NDF, 6.0% CP (DM basis)) at 2% of BW. In Exp. 2, either soybean meal (**SBM**) or fish meal (**FM**) was added to BS+JM to achieve 12% CP. Protein sources of differing rumen degradabilities were fed to determine the potential for associative effects. Sheep were gradually adapted to a diet over a 10-d period fed at 2% of BW. Orts were weighed and then placed directly into the rumen via rumen cannulae. Total feces and urine were collected and subsampled on d 6-10 of each period. Rumen evacuations were conducted on d 10 of each period. Dry matter and NDF were determined for composited fecal and rumen samples for each sheep fed each treatment combination. Dry matter and NDF digestibility results were analyzed using the GLM procedure of SAS. Rumen NDF and DM fill were similar ($P > 0.05$) among sheep and diets; sheep had similar diet digestibilities ($P > 0.05$). The BS+JM diet showed higher ($P < 0.05$) DM and NDF digestibility compared to the 100% BS diet (BS+JM: 56.18, 65.90% ± 1.83; BS: 47.71, 54.39 ± 1.48, for DM and NDF digestibility, respectively). The addition of SBM or FM to the mixed diet had no influence ($P \geq 0.15$) on DM or NDF digestibility (SBM: 49.07, 50.85 ± 1.79; FM: 57.37, 61.26% ± 1.41 for DM and NDF digestibility, respectively). Based on these data, adaptation to diets containing JM may reduce the antimicrobial effects of secondary metabolites found in JM.

Keywords: *Juniperus monosperma*, Juniper, Digestibility

Introduction

There is an abundance of Juniper (*Juniperus monosperma*) in much of the southwestern United States, including New Mexico. Juniper encroachment reduces the availability of desirable forage. One method of control is thought to be defoliation by small ruminants. However, low nutritional quality and high levels of essential oils result in low consumption of juniper by goats (Pritz, 1997). Still, juniper is often grazed when other forage is scarce, such as a period of drought. Laboratory analysis shows that one-seed juniper contains at least 51 terpenoids, some of which have been found to be antimicrobial in nature, and inhibit the growth of rumen and lower gut microbes (Nagy et al., 1964; Oh et al., 1967; Utsumi et al., 2006). In addition, these compounds may contribute to its lack of palatability to the ruminant animal. A reduction in the viability of the rumen microbial population could result in decreased feed digestibility, passage, and yield of fermentation products, leading to compromised animal health (King et al., 1995; Nagy and Tengerdy, 1967). These secondary metabolites, which include terpenes, may also result in toxicosis to the animal, (Estell et al., 2005; Launchbaugh et al., 1964; Pritz et al., 1997; Painter, 1971). However, despite juniper's possible toxicity, it is apparent that it does possess value as a livestock and wild ungulate browse specie. Yet, limited data exist regarding the value, if any, of juniper as a feedstuff, and its effect on the digestibility of other forages. Therefore, information is needed regarding the nutritional value of juniper as a feedstuff.

The objective of this study was to evaluate the digestibility of one-seed juniper when fed with a basal diet of mature buffalo straw hay, as well as evaluate the possibility of any associative effects when juniper is consumed with protein supplements.

Materials and Methods

Five ruminally fistulated crossbred wethers (BW 55 ± 15 kg) were used in two cross-over experiments composed of two 20-d periods to estimate nutritive value of one-seed juniper (*Juniperus monosperma*; JM) as a forage. Juniper was harvested at the Corona Range and Livestock Center, Corona, NM in early September 2005. The Corona Range and Livestock Research Center is located 300 km northeast of Las Cruces, NM (average elevation = 1900 m; average precipitation = 400 mm). Harvested juniper consisted of individual leaves stripped from the ends of branches of immature shrubs. The leaves were stored in a cooler at 4°C for the duration of the study, as Utsumi et al. (2006), showed that cold storage prevents changes in terpenoid profiles. Any particularly large leaf segments were individually cut into smaller pieces (± 5 cm in length) to allow for easier consumption and(or) digestion.

Each 20-d experimental period was made up of two phases. The first phase consisted of 5 d of adaptation to the diet, while the second 5 d made up the collection phase. The diets were then repeated with the remaining animals to conduct the remainder of the crossover

experimental design. In Exp. 1, sheep were fed either 100% buffalo grass straw (*Buchloe dactyloides*; BS) or a mixed diet of 75% buffalo grass straw and 25% juniper (BS+JM) at 2% of BW. In Exp. 2, either soybean meal (SBM) or fish meal (FM) was added to BS+JM to achieve 12% CP. Protein sources of differing rumen degradabilities were fed to determine the potential for associative effects. Orts were weighed and then placed directly into the rumen via rumen cannulae. Nutrient compositions of buffalo grass straw, juniper, soybean meal, and fish meal were determined by methods described above, and are shown in Table 1.

Total fecal and urine collections were taken the last 5 d of each period. A 10% aliquot was reserved each d and compiled by period for later analysis. Urine was frozen until laboratory testing. Feces were divided into two parts, one to remain fresh for nitrogen analysis (Leco FP-528, Leco Corp., St. Joseph, MI) and one to be dried and ground through a 2-mm screen for NDF and mineral (aluminum, cobalt, copper, iron, manganese, molybdenum, and zinc) analysis. Rumen evacuations were conducted on d 10 of each period to account for any residual amounts of feed. Dry matter and NDF were determined for composited fecal and rumen samples for each sheep fed each treatment combination. Nitrogen and mineral retentions were also analyzed using fecal and urine samples. Results of the analysis were used to calculate daily nitrogen retention, NDF digestibility and mineral retention.

Blood samples were collected at 0, 4, and 8 h after juniper consumption via the jugular vein on d 10 of each trial. Samples were centrifuged (1500 × *g* 15 min., 4°C). Serum was separated and stored frozen until analyzed for evidence of toxicosis through testing of liver-specific enzymes, including ALT transfertase and alkaline phosphatase, (Texas Veterinary Medical Diagnostic Laboratory System, Amarillo, TX).

Dry matter and NDF digestibility, nitrogen and mineral retention, and serum clinical profiles were analyzed using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC).

Results and Discussion

Dry matter and NDF digestibility of treatment diets is shown in Table 2. Dry matter digestibility (DM basis) for the basal buffalo grass straw diet was 47.7% ± 1.49 and 56.2% ± 1.49 for the diet containing 25% one seed juniper. Neutral detergent fiber digestibility was 54.4% ± 1.83 for the straw diet and 65.9% ± 1.83 for the juniper containing diet. These results indicate that the consumption of juniper in a diet similar to dormant native range increased total diet digestibility. These digestibility results contrast with the views of Launchbaugh et al., (1997) who stated that the reduced activity of microbes in the digestive tract would lead to decreased diet digestibility. A possible explanation for this contrast may be the length of time sheep were allowed to adapt to juniper in the present study. In addition, White et al., (1980) found that 77% of terpenes are lost through mastication, and may actually never reach the rumen.

Dry matter digestibility (DM basis) for the mixed diet with soybean meal was 49.1% ± 1.79 and 50.8% ± 1.79 for the diet containing fish meal. Neutral detergent fiber digestibility was 57.4% ± 1.41 for the diet containing soybean meal and 61.3% ± 1.41 for the fish meal containing diet. These results indicate that there are a lack of associative effects associated with total diet digestibility when one-seed juniper is fed with protein supplements.

Serum clinical profiles showed no evidence of toxicosis ($P > 0.05$) in levels of the two liver enzymes tested, ALT transfertase and alkaline phosphatase. Normal levels of ALT transfertase are 30 ± 4 U/I, and normal levels of alkaline phosphatase are 178 ± 102 U/I (Kaneko, 1989). Laboratory testing yielded averages of 11.5 ± 0.60 and 11.1 ± 0.60 U/I of serum ALT transfertase for the basal diet and the mixed diet, respectively, and 12.9 ± .34 and 12.2 ± .32 U/I with the additions of soybean and fish meal. Levels were 53.5 ± 1.06 and 54.3 ± 1.06 U/I for serum alkaline phosphatase, respectively, and 58.8 ± 1.50 and 55.8 ± 1.43 U/I with the additions of the protein supplements. These results are consistently below average for toxicosis. These findings are converse to those by Pritz et al., (1997) who found some levels of tissue damage as evidenced by liver-specific enzymes in Angora goats and King et al., (1995) for sheep fed Tarbush, a shrub rich in terpenes. However, it should be noted that Pritz el al., (1995), offered freshly harvested branches which may have accounted for higher terpene concentrations than the cold-stored branches used in this study. We did not measure terpene concentration in juniper leaves and do not know if the harvesting procedure affected the rate of terpene volatilization.

Implications

Results from the current work imply that juniper may indeed be a feasible feedstuff when browsed by small ruminants. Although laboratory measurements indicate that juniper is highly digestible, palatability may reduce its consumption in a practical setting. Thus, adaptation to diets containing juniper may be necessary, and may also reduce the antimicrobial effects of secondary metabolites found in juniper. Digestibility of the diet containing juniper was higher than that of the basal buffalo grass straw diet, implying that the addition of juniper to a range diet will not negatively impact overall diet digestibility over a short period of time. Testing of liver-specific enzymes also yielded no evidence of toxicosis due to the secondary metabolites found in juniper, and although juniper was not analyzed, we believe that juniper consumption did not compromise hepatic function in sheep used in this study.

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Table 1. Nutrient composition of buffalo grass straw, one-seed juniper, soybean meal, and fish meal.

Item	DM %	NDF, %DM	CP, %DM
Buffalo Grass Straw	93.2	76.5	4.7
One-Seed Juniper	72.8	71.7	6.0
Soybean Meal	90.1	8.5	63.1
Fish Meal	90.5	15.9	45.1

Table 2. Dry Matter and Neutral Detergent Fiber digestibility of treatment diets, where BS=buffalo straw, JM=juniper, SBM=soybean meal, FM=fish meal, and SE=pooled standard error.

	Experiment 1			Experiment 2		
Item	BS	BS+JM	SE	BS+JM+SBM	BS+JM+FM	SE
DM digestibility, %	47.7^{a}	54.4^{b}	1.49	49.1^{x}	50.8^{x}	1.79
NDF digestibility, %	56.2^{c}	65.9^{d}	1.83	57.4^{y}	61.3^{y}	1.41

Means lacking a common superscript differ ($P<0.05$)