Proceeding, Western Section, American Society for Animal Science

Vol. 63, 2012

EFFECT OF SUPPLEMENTING ACTIVATED CHARCOAL ON THE INTAKE OF HONEY MESQUITE BY LAMBS

P.E. Mayagoitia-González[1], D.W. Bailey[1], and R.E. Estell[2]

New Mexico State University, Las Cruces[1]; and USDA-ARS Jornada Experimental Range, Las Cruces, NM[2]

ABSTRACT: A study was conducted to determine if intake of honey mesquite (*Prosopis glandulosa* Torr.) leaves by sheep could be increased by supplementing four levels of activated charcoal supplemental (0.0, 0.33, 0.67 and 1.00 g/kg of BW). Twenty wether lambs (36.6 ± 0.6 kg) were randomly assigned to the 4 treatment levels. Lambs were fed 2.0% of body weight of low-quality Sudan-grass hay (*Sorghum bicolor*) and 80 g/d of molasses for 7 days, and then for following 16 days lambs were fed 1.9% of body weight of low-quality Sudan-grass hay and 80 g /day of molasses mixed with the assigned level of activated charcoal. After the 7-d acclimation period, lambs were also given ad libitum access to honey mesquite leaves that had been thawed before feeding. Repeated measures analyses were used to determine if level of activated charcoal fed to lambs affected daily intake of mesquite leaves. No differences ($P = 0.52$) in the intake of mesquite leaves were detected. Mean intake of mesquite leaves was 20.7 ± 3.7, 23.8 ± 3.8, 20.2 ± 3.7, and 27.3 ± 3.7 g/day for the 0.0, 0.33, 0.67 and 1.0 levels, respectively. Consumption of mesquite leaves varied greatly among lambs, ranging from 1.24 to 6.25% of the diet. Differences in hay intake ($P = 0.23$) and lamb weight gain ($P = 0.58$) were not detected among supplemental charcoal treatments. Future studies examining the consumption of honey mesquite leaves by sheep should consider the potential variability in intake among individual animals.

Key words: activated charcoal, honey mesquite, molasses, Sudan-grass hay, wethers.

INTRODUCTION

Honey mesquite (*Prosopis glandulosa*) is a highly invasive species found throughout the Southwest. It outcompetes other plant species in search for water, light and nutrients, and reduces amount of desirable foraging species. Control methods such as mechanical and chemical removal are often not cost-effective. Therefore, using mesquite as a forage resource in southwestern rangelands could increase the sustainability of livestock operations (Witmore, 2009).

Potentially, mesquite could be a valuable forage resource, because its crude protein content and fiber levels are similar to moderate quality alfalfa hay. However, phenolic compounds in its leaves can be detrimental for ruminant animals (Lyon et al., 1988). Poage et al. (2000) used activated charcoal to increase intake of bitterweed, which contains sesquiterpenes. Authors suggested activated charcoal reduced toxicosis and ultimately increased bitterweed consumption. Witmore (2009) also indicated supplementation of activated charcoal might enhance intake of mesquite leaves by livestock.

The objective of this study was to evaluate free choice consumption of mesquite leaves by sheep with activated charcoal supplementation. We hypothesized that there would be a non-linear relationship between intake of activated charcoal (medicine) and mesquite leaves (source of toxins).

MATERIALS AND METHODS

The New Mexico State University Animal and Use Committee approved the research protocol.

Feeding Trials. Our study was conducted during the winter of 2012 (mid-January to early February) and lasted 24 days. Twenty yearling Rambouillet wether lambs (36.6 ± 0.6 kg) were randomly assigned to 4 treatments in a completely randomized design. Treatments consisted of 4 levels of daily supplementation of activated charcoal: 0, 0.33, 0.67 and 1g/kg of BW. Lambs were kept in individual pens and fed daily at 0800 and 1700 h. Lambs were weighed before and after the study. During a 7-d adjustment period, lambs were fed Sudan grass hay (*Sorghum bicolor*) at 2.0% of BW (**DMB**) and 80 g of molasses. Following the acclimation period, a 17-d feeding trial was conducted. Lambs were fed low quality hay at 1.9% of BW (DMB) and a mixture of molasses (80 g) plus activated charcoal each day. The mixture of molasses and activated charcoal was placed on top of the hay in a rubber pan. Mesquite leaves were offered ad libitum in a separate pan. Mesquite leaves were harvested by hand at the Chihuahuan Desert Rangeland Research Center located 35 km north of Las Cruces, NM and placed in a cooler with ice for a maximum of 3 h and then frozen and stored until the trial. About 2/3 of the mesquite leaves were harvested on June 15 2011 and remaining leaves were harvested on June 29 2009. All lambs were fed leaves from each harvest date an equal number of days. Mesquite leaves were thawed in a refrigerator the night before feeding. Based on intake levels observed by Witmore (2009), we initially placed 11 g DM of mesquite leaves in each feeder during the morning when hay and molasses were fed. In the evening (1700 h), feeders were monitored and more mesquite was placed in the feeder if 75% of the mesquite leaves were consumed. During the first 4 days, all lambs received the same amount of leaves unless 75% of the leaves were consumed in the morning meal.

After 4 days, an additional 11 g DM of mesquite leaves were offered per meal if lambs consumed all leaves the previous day. The amount of leaves was reduced if lambs consumed less than 50% of the leaves the previous day. Our approach was to ensure lambs had ad libitum access to mesquite leaves without feeding excessive amounts of harvested mesquite leaves.

Hay and mesquite orts were collected each morning. Orts were weighed daily and stored until the end of the trial. Hay and mesquite orts were dried at 50°C for 48 h and ground in a Wiley mill to pass a 1-mm screen. Hay, mesquite leaves, and orts were composited across days and analyzed for CP, NDF, and ADF (SDK Labs, Hutchison, KS) using standard analytical procedures. All intakes and nutrient concentrations are expressed on a DM basis.

Statistical Analysis. Intake of mesquite leaves was analyzed using the repeated measure of PROC MIXED (SAS Inst. Inc., Cary NC). The model included treatment (level of activated charcoal supplementation), day, and treatment by day interaction. Lamb was used as the subject and covariance between repeated records was modeled using autoregressive order1, compound symmetry, and unstructured covariance structures (Littell et al., 1996). Of the three covariance structures evaluated, the structure resulting in the lowest Akaike's Information Criterion (**AIC**) value was selected. Mean mesquite and hay intake after the acclimation period was evaluated with PROC MIXED using a model that contained treatment.

RESULTS AND DISCUSSION

Chemical Analyses. The Sudan grass hay used in this study was low quality with a relative feed value of 78. Crude protein concentration was 10.51%. The NDF and ADF values were 63.57% and 45.80%, respectively. In contrast, the relative feed value of mesquite leaves (143) was equivalent of moderate quality alfalfa hay. The crude protein concentration of mesquite leaves was 16.10% and NDF and ADF levels were 40.73 and 33.65%, respectively. Regarding crude protein content, our results differ with those of Lyon et al. (1988), where nutritive values of 6 mesquite species were compared with alfalfa (*Medicago sativa* L); the lowest CP content was for *Prosopis alba* with 15%. Conversely, NDF and ADF values reported by Lyon et al. (1988) were similar to those in our study (35.5 and 43.3% for *P. nigra and P. alba*). Similarly, Witmore (2009) reported similar NDF and ADF values for small (40.9 and 27.2%) and large mesquite leaves (36.4 and 29.2%), but CP concentrations in that study for small and large leaves (21.3 and 20.7%, respectively) were greater than those observed in this study. Crude protein values in this study are similar to those obtained by Riveros (1992) for *Prosopis tamarugo* leaves.

Mean Intake. No differences ($P = 0.23$) in hay intake were detected among treatments (Table 1). Similarly, no differences among treatments ($P = 0.61$) were detected in mean mesquite leaf intake. When expressed as a percentage of the diet, mesquite intake averaged 3.65% and varied from 1.24 to 6.25% of the diet. During the first half of the trial (first 8 d), mesquite intake varied from 0.06 to 7.42% of the diet. During the second half of the study (d 9 to 16), mesquite leaves comprised 1.44 to 7.58% of the diet. Negative post-ingestive feedback has been reported with inclusions of more than 5% of the diet as honey mesquite (Witmore, 2009; Baptista and Launchbaugh, 2001). However, a 6-mo study conducted by Abedelnoor et al. (2009) feeding *P. juliflora* leaves at varying levels (5 to 15%) with silage to sheep revealed that organic matter digestibility was improved when mesquite was added to the diet at 5 and 10%. Moreover, they suggested sheep could tolerate this species with silage at up to 15% of the diet. Abedelnoor et al. (2009) indicate that if appropriately mixed with other forages, mesquite is a viable feeding source during dry seasons.

No differences in lamb weight gain were detected ($P = 0.58$). Overall lambs lost 2.32 ± 0.62 kg during the study.

Daily Intake. No differences in daily intake of mesquite leaves were detected ($P = 0.52$). Intake of mesquite leaves changed ($P < 0.001$) during the course of the study. Lambs consumed more mesquite as the study progressed (Figure 1). Intake of mesquite leaves followed a cubic function of day of study:

$$\text{Intake (g/d)} = -6.62 + 8.87*\text{day} - 0.94*\text{day}^2 + 0.04*\text{day}^3$$

Intake of mesquite leaves varied greatly among lambs during the study (Figure 2). Mesquite intake often followed cyclical patterns. Periods of high intake were often followed by periods where lambs consumed few, if any, mesquite leaves. Witmore (2009) reported a similar trend in which intake of mesquite leaves varied cyclically.

In contrast to this study, intake of forages with plant secondary metabolites has been enhanced by supplementation in other studies. Banner et al. (2000) conducted 3 experiments to determine the effect of activated charcoal and barley on sagebrush intake by lambs. In the first experiment, activated charcoal and barley increased sagebrush intake significantly (304 g) compared with the treatment with just barley (248 g). However, Banner et al. (2000) suggested barley had a pivotal role on sagebrush consumption because it has sulfur-containing amino acids that facilitate detoxification. Witmore (2009) observed increased intake of honey mesquite leaves with supplementation of activated charcoal. That study utilized a crossover design with lambs as their own control and a shorter feeding period (Witmore, 2009).

IMPLICATIONS

Honey mesquite is a shrub found extensively throughout the Southwest that has a relatively high nutrient content compared with grasses during late spring and early summer. Little research has been conducted to assess its effects on livestock or on mechanisms to increase intake. Further studies are needed to understand how honey mesquite affects livestock and how it can serve as a forage to enhance the sustainability of livestock grazing in the southwestern United States and arid regions around the world.

Table 1. Mean intake of Sudan hay and honey mesquite leaves of lambs supplemented with four levels of activated charcoal

Level of Activated Charcoal Supplementation	Sudan Hay, g/d		Mesquite Leaves, g/d		Mesquite Leaves in Diet, %	
Item	Mean	SE	Mean	SE	Mean	SE
0.00 g/kg BW	612.4	33.4	20.8	4.3	3.00	0.66
0.33 g/kg BW	540.8	33.4	24.8	4.3	4.02	0.66
0.67 g/kg BW	563.0	33.4	20.2	4.3	3.18	0.66
1.00 g/ kg BW	512.0	33.4	27.3	4.3	4.41	0.66

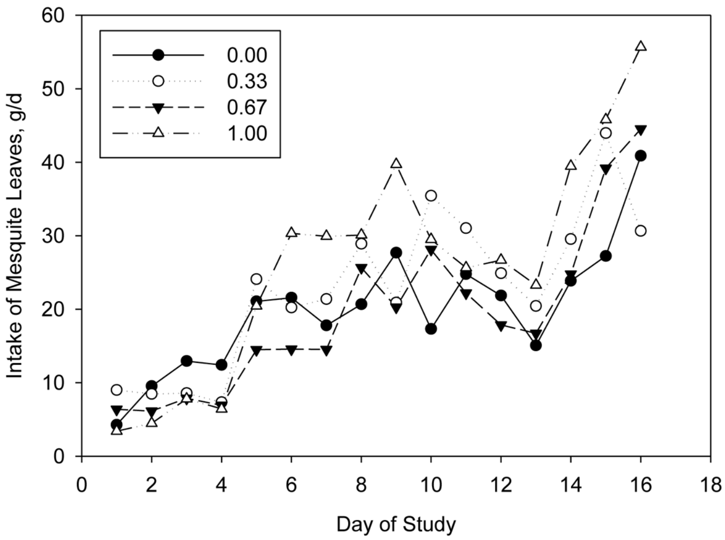

Figure 1. Daily intake of honey mesquite leaves by lambs supplemented with activated charcoal at 0.00, 0.33, 0.67, or 1.00 g/kg BW.

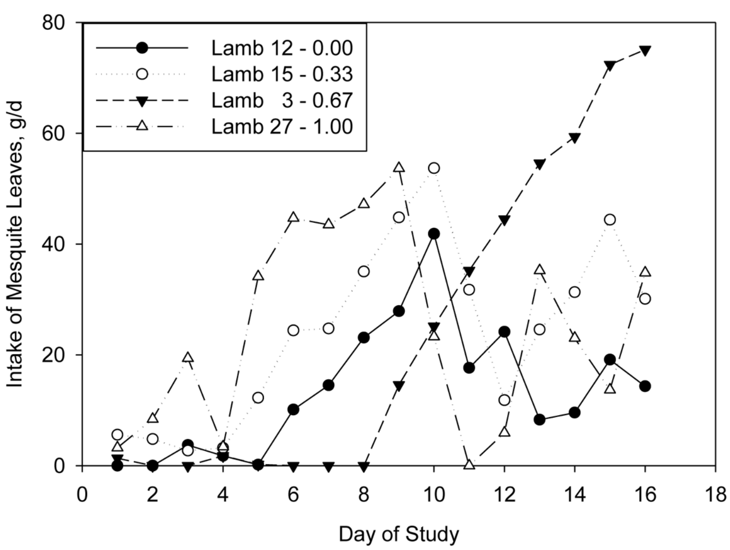

Figure 2. Examples of daily intake of mesquite leaves by individual lambs supplemented with 0.00, 0.33, 0.67, and 1.00 g/kg BW of activated charcoal.

LITERATURE CITED

Abedelnoor, T. M., N. H. Talib, A. A. Mabrouk, M. A. Mohammed, M. I. El-Mahi, H. H. Abu-Eisa, Z. Fre, and H. Bokrezion. 2009. The use of alternative animal feeds to enhance food security and environmental protection in Sudan. *In:* Zeremarian Fre (ed). Final Report: Pastoral and Environmental Network in the Horn of Africa and Animal Production Research Center. PENHA-APRC. www.penhanetwork.org

Baptista, R., and K. L. Launchgaugh. 2001. Nutritive value and aversion of honey mesquite leaves to sheep. J. Range Manage. 54:82–88.

Banner, R.E., J. Rogosic, E. A. Burritt, and F. D. Provenza. 2000. Supplemental barley and charcoal increase intake of sagebrush (*Artemisia tridentata* subsp. *vaseyana*) by lambs. J. Range Manage. 53: 415–420.

Littell, R. C., G. A. Milliken, W. W. Stroup, and R. D. Wolfinger. 1996. SAS sytem for mixed models. 6th ed. SAS Institute, Cary, NC.

Lyon, C. K., M. R. Gumbmann, and R. Becker. 1988. Value of mesquite leaves as a forage. Journal of the Science of Food and Agriculture 44: 111-117.

Poage III, G. W., C. B. Scott, M. G. Bisson, and F. S. Hartmann. 2000. Activated charcoal attenuates bitterweed toxicosis in sheep. J. Range Manage. 53: 73.

Riveros, F. 1992. The genus Prosopis and its potential to improve livestock production in arid and semi-arid regions. p. 257-276 *In:* Speedy, A. and Pugilese (eds). Legume trees and other fodder trees as protein sources for livestock. FAO Animal and Production Health Paper, FAO, Rome, Italy.

Witmore, B. K. 2009. Potential of biological control of honey mesquite and its use as a forage resource for livestock. Thesis, New Mexico State University, Las Cruces.