

Nutritional properties and intake and digestibility in sheep and goats of Oak (*Quercus durata*) and Chamise (*Adenostoma fasciculatum*).<sup>1</sup>

Brosh, A.<sup>2</sup>, N. Narvaez<sup>3</sup>, M. Lane<sup>4</sup>, M. Dally<sup>3</sup> and W. Pittroff<sup>3</sup>

<sup>2</sup> Agricultural Research Organization, Newe Ya'ar, Israel; <sup>3</sup> Department of Animal Science, University of California, Davis; <sup>4</sup> School of Veterinary Medicine, University of California, Davis

<sup>1</sup> Supported by the California Agricultural Experiment Station

Keywords: *Quercus durata*, *Adenostoma fasciculatum*, Goat, Sheep, Intake, Digestibility, Forage quality, Chemical composition.

### Introduction

More than 4.5 million ha of California's rangelands are dominated by the *Chaparral* plant community. This Mediterranean type brush community is one of the most flammable plant communities in the world. Its succession is fire dependent. Human management impacts on the fire cycle are not well understood. With the rapid expansion of human settlement in previously rural areas throughout the range of the Chaparral community comes a dramatic increase in the risk of loss of life and property due to catastrophic wildfires. There is growing interest in and application of so-called 'pre-scribed grazing' with small ruminants, particularly goats, in effort to reduce fire fuels in California Chaparral communities. However, very little is known about the nutritional and anti-nutritional properties of the plant species intended to be consumed by domestic ruminants in Chaparral management programs. This information is essential to design management protocols required to ensure health maintenance of the animals and predict efficacy of their use.

The study was conducted to determine intake and digestibility *in vivo* in sheep and goats of two key species of California Chaparral, and provide basic data on nutritional properties by chemical analysis.

### Material and Methods

*Study area.* The feeding experiment was conducted in October – November 2000 in the Hopland Research and Extension Center (HREC), located at 39° 00'N latitude and 123° 4'W longitude with elevation from about 170 to 1,000 m. Four principal vegetation types (grass, woodland-grass, dense woodland, and chaparral) include more than 800 species and cover 95% of the Center's property.

*Plant material.* Oak (*Quercus durata*) and Chamise (*Adenostoma fasciculatum*) foliages were hand-harvested daily each morning from a stand located on HREC. Harvesting of branches was done in a matter consistent with browsing patterns of sheep and goats in order to minimize refusals. Because of suspected low protein availability in oak and chamise, supplementation with Lucerne pellets was indicated to not compromise animal health of the experimental animals, which were all growing. Fresh drinking water was available at free choice.

*Animal management.* The experiments were carried out with four castrated male Kiko goats (average weight 22.9±2.7 kg) and four wether Targhee sheep (average weight 39.6±0.66 kg) held in separate metabolism cages. Prior to the beginning of measurements, animals were adapted to each diet over at least a 7-day period. The experiment was designed as a 2 x 2 factorial arrangement of treatments (plant species chamise and oak) and animal species (goat vs. sheep) to determine *in vivo* intake and digestibility of Oak and Chamise as a base-diet. Plant material was daily offered and lucerne pellets were used as supplement of the diets at 2% of animal body weight as fed.

*Measurements.* Feed intake and *in vivo* diet digestibilities were measured by total fecal collection. Daily subsamples from the fresh feed offered and from composited total feed refusals for each individual animal were weighed and taken for DM determination and further analyses. Samples of feed on offer, refusals and feces were dried in a forced-air oven (50°C for 48 h) and ground to pass a 1 mm-screen in a Wiley mill (Arthur A. Thomas, Philadelphia, PA) and stored until analysis.

*Laboratory analyses.* Feed on offer and individual refusal and fecal samples were analyzed for dry matter (DM), organic matter (OM), ash, and crude protein (CP) according to AOAC (1975). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined following Goering and Van Soest (1970). The complete digestibility analysis yielded also data for digestibility of crude protein (CPD), NDF (NDFD) and ADF (ADFD).

*Statistical analysis.* Data were analyzed in mixed model-maximum likelihood linear models for analysis of repeated measure data with a 2 x 2 factorial arrangement of treatments, using SAS 8.1 software (SAS, 1999). A compound symmetry covariance structure was fitted to all response data, as indicated by Akaike's Information Criterion. Observed values for dry matter and crude protein digestibility were transformed with the arcsine square root transformation to approximate normal distribution. Animal and plant species were the main effects in the model. The interaction effect between animal and plant species was included in the full model.

## Results and Discussion

*Nutritional properties of oak and chamise.* Chemical composition of oak and chamise foliage data are given in Table 1. Oak foliage had higher concentrations of ash, CP and NDF and lower content of ADF than chamise. The results demonstrate that both species contained substantially less protein than required by sheep and goats. Supplementation with protein is, therefore, required for animals to perform without serious performance and health consequences.

Parameters	Oak	Chamise	Lucerne
Dry matter (%)	63.4	52.9	93.8
Organic matter (%)	96.4	97.6	88.8
Ash (%)	3.6	2.4	11.2
Crude protein (%)	4.6	3.8	20.3
NDF (%)	53.9	45.9	37.3
ADF (%)	38.3	40.0	28.8

Table 1. Chemical composition (%DM) of Oak, Chamise and lucerne pellets on offer

The CP values observed in our study are considerably lower than those reported by Sidahmed et al. (1981); on the other hand, our *in vivo* digestibility values are almost twice as high as the *in vitro* values found by these workers.

*Intake and digestibility of the diet.* Animal species ( $p < .0001$ ), plant species ( $p = 0.188$ ) and their interaction ( $p < .0001$ ) were significant factors contributing to variability of intake data. Animal ( $p = .0016$ ) and plant species ( $P = .0088$ ) were also highly significant for dry matter digestibility; while animal species was highly significant also for digestibility of crude protein ( $p = 0.0014$ ), plant species only approached significance ( $p = .0545$ ). In both of the latter response variables, the interaction between animal and plant species was not significant. Animal species was not significant in the digestibility coefficients of NDF and ADF, but plant species approached significance for digestibility of NDF ( $p = 0.06$ ), and was significant ( $p = .007$ ) for ADFD. Table 2 summarizes raw means for dry matter voluntary intake (DMI) and digestibility

coefficients for goats and sheep fed oak and chamise. Goats consumed more on a per body weight basis than sheep. The intake values for oak and chamise only (Table 2) are comparable to the 18.5 g DMI per kg BW reported by Sidahmed et al. (1981) for goats fed a mixed brush diet comprising another oak species (*Quercus dumosa*), chamise, and manzanita (*Arctostaphylos glandulosa*).

Response	Oak	Chamise	Significance	
			Goat vs. Sheep	Chamise vs. Oak
<b>Goats</b>				
<i>Dry matter intake</i>				
DMI (g/d)	450.5	541.9	***	*
DMI (g/kgBW)	20.0	23.6	***	*
Total diet (g/d)	684.4	977.1	***	*
Total diet (g/kgBW)	30.3	42.5	***	*
<i>Digestibility coefficients</i>				
DMD	52.33	50.1	*	*
OMD	52.9	50.5	*	*
CPD	72.5	71.0	*	*
NDFD	13.4	3.59	ns	(ns)
ADFD	8.9	-0.65	ns	*
<b>Sheep</b>				
<i>Dry matter intake</i>				
DMI (g/d)	532.9	465.1	***	*
DMI (g/kgBW)	13.6	11.7	***	*
Total diet (g/d)	975.3	1219.3	***	*
Total diet (g/kgBW)	24.8	30.7	***	*
<i>Digestibility coefficients</i>				
DMD	55.6	53	*	*
OMD	56.3	53.3	*	*
CPD	67.6	67.0	*	*
NDFD	10.6	10.2	ns	(ns)
ADFD	9.3	6.1	ns	*

\*\*\* p<0.0001; \*\* p<0.001; \* p<0.05

Table 2. Dry matter intake and in vivo digestibility coefficients in goats and sheep fed *Q. durata* and *A. fasciculatum*.

Nutritional quality and intake levels of chamise and oak are low in sheep and goats, and demonstrate the need for some minimal supplementation of animals employed in vegetation management programs. Goats preferred chamise, while sheep preferred oak. Digestibility of both species was higher in goats than in sheep, and generally higher for oak than for chamise. With these data, expected performance levels may be estimated for sheep and goats used in vegetation management programs, because these two species make up the major proportion of the diet of small ruminants browsing chaparral (Sidahmed et al., 1981). Predicted performance level would be useful for the estimation of cost of animal management. Personal observations suggest that livestock operators in California frequently use goats in vegetation control programs under a management regime that leads to severe condition loss. More research on the effects on nutritional and health status of animals employed in vegetation management in California is needed in order to develop this service into an economically viable activity for livestock producers.

### **Literature cited**

- Association of Official Analytical Chemists. 1975. Official methods of analysis. 12<sup>th</sup> ed. AOAC, Washington DC.
- Goering, H. K., and P. J. Van Soest. 1970. Forage fiber analyses. Handbook, Agricultural Research Service, United States Department of Agriculture, N° 39.
- Sidahmed, A. E., J. G. Morris, and S. R. Radosevich. 1981. Summer diet of Spanish goats grazing chaparral. *Journal of Range Management* 34(1):33-36.
- Statistical Analysis Systems Institute (SAS). 1999. SAS User's Guide: Statistics, Version 8.1. SAS Inst. Inc., Cary, NC.