Nutritive value of chaparral for goats grazing in fuel-breaks

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Spanish goats, used for fuel-break maintenance in chaparral after fire, browsed resprouting vegetation, selecting most nutritive plant parts. Goat with harness (right) is one of esophageal fistulated animals from which samples were collected daily. At far right is resprouting scrub oak and chamise at U.S. Hopland Field Station, Mendocino County; below, goats in test plot at Tragedy Springs, Cleveland National Forest, San Diego County.

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Chaparral, a major vegetation type in California covering 3.4 million hectares (ha), or approximately 8.5 percent of the state, is characterized by dense, evergreen shrubs with thick, hardened leaves. The dense shrub cover and abundance of dead material through the canopy, coupled with hot rainless summers, make chaparral one of the most fire-susceptible vegetation types in the world. After fire, the shrub species rapidly reoccupy sites by either fire-induced germination of seed reserves in the soil or sprouts from below-ground vegetative organs. Fuel-break maintenance is, therefore, a problem in most chaparral areas.

In California, chaparral includes the genera *Adenostoma, Quercus, Ceanothus,* and *Arctostaphylos*. Since the summer of 1977, we have conducted experiments at two locations—Cleveland National Forest, San Diego County, and the University of California Hopland Field Station, Mendocino County—to investigate potential utilization of chaparral shrub seedlings or sprouts by Spanish goats for fuel-break maintenance.

We observed that the goats prefer sprouts of scrub oak (*Quercus dumosa*), chamise (*Adenostoma fasciculatum*), and manzanita (*Arctostaphylos glandulosa*), in that order. The species specificity demonstrated by Spanish goats may influence ultimate site dominance, should goat grazing become common for fuel-break maintenance in chaparral. Grazing may change the chemical composition of these shrub species, which could influence the degree of utilization as grazing time proceeds. Cover differences between available browse before and after grazing also might affect goat preference and dietary composition.

Our objectives were to study the nutritive value of pre- and post-browsed sprouting shrub species. We also compared digestibility and chemical composition of dietary samples (those collected by goats) with hand-harvested samples.

Sampling procedure

A 3.2-ha chaparral-dominated site at the University of California Hopland Field Station (985-meter elevation) was burned in June 1978. Immediately after the fire, the study area was fenced to exclude deer and other large grazing animals. Four 0.20- to 0.26-ha plots were constructed inside the enclosure. Each plot was browsed by the same 12 goats in the following sequence: plot 1, April 21 to May 12; plot 2, May 15 to June 7; plot 3, June 8 to July 1; plot 4, July 3 to July 25. Since considerable regrowth of

shrubs occurred after grazing, plot 2 was also grazed from August 6 to August 20.

Leaves and twigs of green shoots were harvested from each plot before grazing and after the 12-day grazing period. Vegetative cover was determined before and after each grazing period from 10 permanent transects established in each plot (table 1). Except for 2.1 percent cover of herbaceous plants in plot 3, shrub species constituted the only vegetation present in this study.

Dietary samples were collected daily from four esophageal fistulated goats confined to each plot. Both dietary and hand-harvested samples were frozen, freeze-dried, and ground before chemical analysis. Samples were analysed for nitrogen (N), fiber, and tannin content. Tannins were estimated as the difference between acid detergent fiber (ADF) and the sequential acid detergent residue of neutral detergent residue (NAD). *In vitro* dry matter digestibility (IVDMD) values for both hand-collected and goat-diet samples were determined. Rumen liquor for IVDMD was obtained from a donor goat fed 65 percent shrub and 35 percent alfalfa feed mixture. Botanical composition of dietary samples was determined microhistologically.

Results and discussion

Goats discriminated against plant parts that were low in nitrogen, but high in cell wall contents (CWC) and cellulose (NADC). Hand-collected chamise had higher nitrogen concentration before (1.21 percent) than after (0.89 percent) grazing; CWC increased from 50 to 59.5 percent (table 2). Similar observations were made for scrub oak and manzanita. No differences between pre- or post-browsed shrubs were observed for lignin (NADLs), tannins, or ash.

All hand-collected samples (before and after grazing) had low (28 to 39 percent) IVDMD values. However, dietary samples

TABLE 1. Cover of three chaparral shrubs following fire and before and after goat browsing

Plot number	Botanical composition (% cover) before and after grazing†					
	Chamise		Scrub oak		Manzanita	
	Before	After	Before	After	Before	After
	%	%	%	%	%	%
1	11.6	11.1	4.6	1.4	—	—
2-I	7.9	7.9	2.7	1.4	2.3	3.4
2-II	6.3	0.8	2.8	0.5	3.9	3.9
3	14.4	12.3	6.6	1.6	—	—
4	7.4	1.9	15.4	6.2	2.8	3.2

†Data recorded from 10 permanent transects in each plot. Plot 2 was grazed twice (2-I in May-June, 2-II in August).

TABLE 2. Chemical composition and *in vitro* digestibility of sprouts of three hand-harvested shrub species before and after goat browsing

Shrub	Browsing by goats	Dry matter†							
		CWC	Lignin	Cellulose	Ash	Nitrogen	Tannins	Moisture	IVDMD
		%	%	%	%	%	%	%	%
Chamise	Before	50.0	13.4	21.8	3.5	1.21	3.4	52.4	34.2
	After	59.5	14.0	26.9	3.5	0.89	3.8	48.5	28.4
Scrub oak	Before	56.0	12.6	25.0	3.9	1.26	2.2	50.7	39.1
	After	66.4	12.7	32.5	4.2	0.88	2.9	44.9	32.0
Manzanita	Before	43.7	16.4	17.4	3.8	0.92	0	55.0	31.6
	After	48.5	16.2	21.7	4.3	0.89	0	54.0	30.3

†CWC = cell wall content; IVDMD = *in vitro* dry matter digestibility; Tannins = the difference between acid detergent fiber (ADF) and sequential acid detergent residue of neutral detergent residue (NAD), and mainly estimates condensed tannins.

Scrub oak after fire but before browsing by goats.

TABLE 3. Comparison of *in vitro* digestibility values from hand-collected shrubs and dietary samples from goats with esophageal fistulae

Shrub	*in vitro* digestibility		Contribution of major shrub species in diet samples
	Hand-collected	Esophageal	
	%	%	%
Chamise	32.5 ± 2.2†	45.6 ± 1.3	84.4 ± 8.4
Scrub oak	36.6 ± 1.3	48.3 ± 3.3	72.6 ± 6.8
Manzanita	31.0 ± 0.3	47.6 ± 6.1	82.0 ± 2.52

†Mean ± one standard deviation.

TABLE 4. Correlations between composition and digestibility of each shrub species.

Chemical constituent	Shrub species	Correlation coefficients between *in vitro* digestibility and composition		
		Before browsing	After browsing	All samples
CWC	chamise	−.98***	−.98**	−.98***
	scrub oak	−.97***	−.85	−.95***
	manzanita	−.30	−.89*	−.52
Lignin	chamise	−.32	−.89*	−.53
	scrub oak	−.65	+.38	−.39
	manzanita	+.03	−.02	+.03
Nitrogen	chamise	+.93***	+.58	+.80***
	scrub oak	+.93***	+.86	+.94***
	manzanita	+.14	+.67	+.00
(ADF-NAD) tannins	chamise	+.32	−.93*	+.01
	scrub oak	−.01	−.28	−.27
	manzanita	+.61	−.10	+.26

*, **, *** = Correlations significant at P<.05, P<.01, P<.001 levels respectively.

had 11 to 14 percent higher IVDMD values than hand-collected samples (table 3). The contribution of individual shrub species in these esophageal samples ranged from 60 to 100 percent. Apparently, even when goats are forced to eat a less preferred shrub species such as manzanita, they select the plant parts that are more digestible than those provided in hand-collected samples.

Earlier, in a digestion study with caged goats at Davis, we observed that hand-harvested (leaves and twigs) feed mixtures of these three shrub species provided a maintenance diet only when mixed with herbaceous plants. When the shrubs were the only dietary components, submaintenance intakes occurred. In this study, all goats were able to select and obtain a maintenance diet, even though only the shrub species were made available to them for grazing. These findings show that goats are capable of being more selective than simply distinguishing between leaves and twigs, as we did when hand-harvesting samples for the digestion study.

Except for pre-browsed, hand-collected manzanita samples, cell wall content was negatively and nitrogen positively associated with IVDMD (table 4). These two factors are also a function of age of the browse. The percentage of the lignin-cutin complex (NADLs) was high in the shrub samples (13 to 16 percent), but this did not seem to affect the extent of digestibility except for post-browsed chamise. These observations contrast with those for common forages, where lignin often limits digestibility more than CWC.

Some *in vitro* digestibility studies have reported an inhibitory effect of tannins on digestibility if concentrations exceeded 4 percent. In this study, the mean ADF-NAD tannins were between 0 and 3.8 percent, and therefore the poor tannin-digestibility correlations were obtained.

Summary

In all plots, Spanish goats browsed scrub oak most and manzanita least. However, when goats were forced to consume a diet high in manzanita, they collected plant parts of highest nutritive value. The goats discriminated against portions of the shrub with high cell wall content and low nitrogen. Tannins and lignin did not contribute significantly to the variation in *in vitro* dry matter digestibility, while cell wall content and nitrogen were closely associated with digestibility. These results suggest that the level of nitrogen in the shrubs has a greater effect on digestibility than either lignins or tannins. Another explanation could be that immature browse is associated with high nitrogen and low cell wall contents.

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