THE UNIVERSITY OF ARIZONA
Cooperative Extension

Nutritional Characteristics of Arizona Browse

Browse Utilization by Ruminant Animals

Hofmann (1988) characterized ruminant animals as either browsers, intermediate feeders, or grazers. Browsers such as deer and moose are identified as those animals which consume a diet largely consisting of highly digestible forbs (broad leaved weeds and legumes) and browse (leaves from woody plants). Grazers such as cattle and bison consist of ruminant animals which consume a large proportion of grasses for their diet. Intermediate feeders such as elk and goats (and to a lesser degree, sheep) are opportunistic feeders who will shift diet selection among browse, forbs, and grasses according to seasonal palatability and availability. Different classes of ruminants have physical adaptations in several body features including rumen architecture, teeth, mouth, and the tongue to enable them to more effectively process their chosen diet.

For example, deer have a small pointed muzzle with a narrow tongue to assist in obtaining a highly selected diet of forbs and browse. They also have a rumen structure to facilitate a rapidly digested diet and a larger liver (per unit of body weight) to process potentially harmful secondary compounds (such as tannins) which often occur in browse. Cattle, on the other hand, have a broad flat muzzle, flat teeth for grinding a high fiber grass diet, and a very large rumen to accommodate the extra time needed to process a slowly digested diet.

When the occurrence of grass and forbs declines in a particular pasture, cattle will include a larger portion of browse in the diet, reducing the amount of total forage consumed (Stuth and Lyons, 1999). The reduction in intake is directly attributable to a lack of physical adaptations to handle a high browse diet. Negative nutritional effects for cattle consuming browse will vary depending upon the total amount consumed, the stage of plant growth, and the presence or absence of harmful secondary compounds in the browse species.

Goats appear to select (Hofmann, 1988; Lyons et al., 1996) and more effectively process (Davis et al., 1975; Radostits et al., 1994) a browse diet containing more tannins. However, research has shown that goats will avoid diets containing large amounts of tannins (Holechek et al. 1990). Diets containing large

Key Points

1. Shrubs tend to maintain nutritive value for phosphorous and crude protein better than do grasses.
2. Although many chaparral browse species may test higher in crude protein than grasses, tannins present in some browse species can make protein and energy in the browse less digestible and less available than for grasses.
3. When cattle diets include 50% or greater of the diet as oak browse, detrimental effects to animal health and productivity can occur.
4. Adapted animals are more proficient at utilizing browse containing tannins than unadapted animals.
5. Winter moisture appears to be critical for adequate growth of shrubs. Crude protein in shrubs is usually highest in early spring or for some browse species, in summer following rain. Crude protein in browse can be expected to decline with less rainfall, especially inadequate winter rainfall.
6. Preliminary investigation implies that browse **may** be higher in trace mineral concentrations than grasses but data is somewhat limited for this nutritional characteristic.
7. Cattle utilizing browse ranges with a majority of the plant composition consisting of oak species are good candidates for winter protein supplementation.

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percentages of tannin containing forages (18% mesquite; 10% creosote) caused toxicosis in goats, lower forage intake, and lower forage digestibility (Holechek et al., 1990). This was not the case for diets containing shrubs with low concentations (23% fourwing saltbush; 25% winterfat) of tannins (Holechek et al., 1990).

Browse species can generally be characterized for animal preference and palatability according to the amount of secondary plant compounds (such as tannins) they contain. Shrubs like fourwing saltbush and winterfat containing low amounts of harmful secondary compounds and few physical barriers to browsing (such as spines) are highly preferred (Holechek et al., 1990). As mentioned previously, most browse species containing large concentrations of tannins such as creosote, mesquite, and one-seed juniper are largely avoided, although mesquite beans are often sought after and consumed by domestic livestock. One species which has been shown to contain higher amounts of tannins but yet does not appear to appreciably affect forage intake or forage digestibility by goats is mountain mahogany (Boutouba et al., 1990). In this study, mountain mahogany was fed to goats at a rate of 60% of the daily diet. When mountain mahogany was fed at low levels to cattle (20% of diet, Arthun et al., 1988; 20% of diet, Arthun et al., 1992), no negative digestibility effects were noted, but it appeared that increasing the amount of mountain mahogany to 31% of the cattle diet caused a slight decrease in forage digestibility (Arthun et al., 1988).

Arizona Browse Rangelands

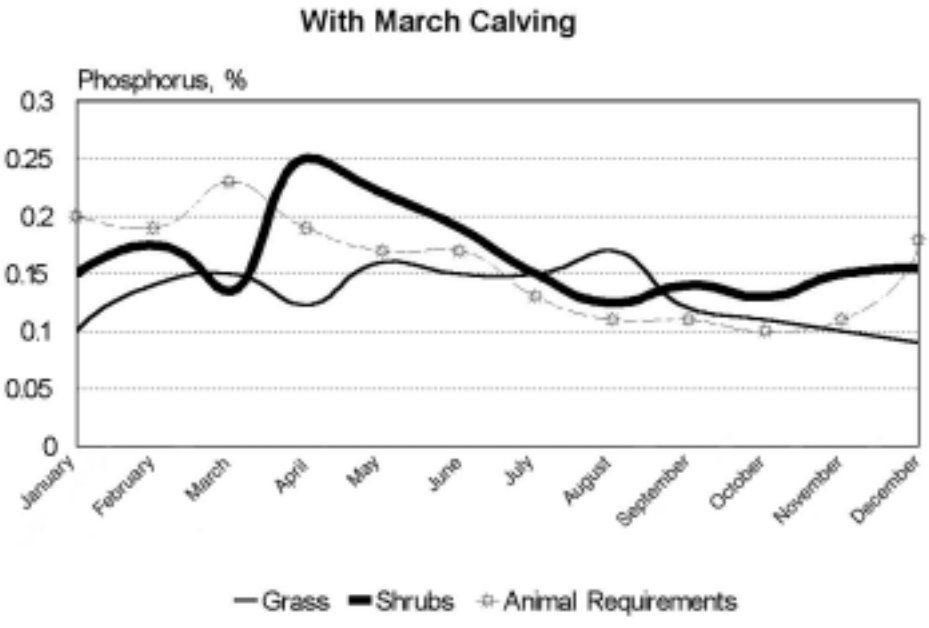
In Arizona, large sections of rangeland are dominated by shrubs. For example, the Arizona Interior Chaparral range type occupies approximately 3.2 million acres and is dominated by several browse species, among which turbinella oak is most prominent. Other important browse species in Arizona, depending upon location, are desert ceanothus, mountain mahogany, cliffrose, Wright's silktassel, hollyleaf buckthorn, winterfat, fourwing saltbush, squawberry, and jojoba.

Highly palatable browse species in Arizona include fourwing saltbush, winterfat, and cliffrose. Moderately palatable shrubs include jojoba, ceanothus, mountain mahogany, turbinella oak, hollyleaf buckthorn, and Wright's silktassel. Mostly unpalatable browse species include manzanita, blackbrush, mesquite leaves, and creosote bush. Large fluctuations in browse consumption can and does occur, depending upon climatic conditions, growth form and availability of different browse species, and the presence of other forage classes such as winter annuals.

As an example of the fluctuation that exists in browse consumption, consider the consumption of desert ceanothus and turbinella oak on the Wagon Bow Ranch in Mohave County over six years time (Rob Grumbles, unpublished data, 1984-1990). The percentage of these shrubs in the diet was estimated monthly by microscopic examination of fecal samples.

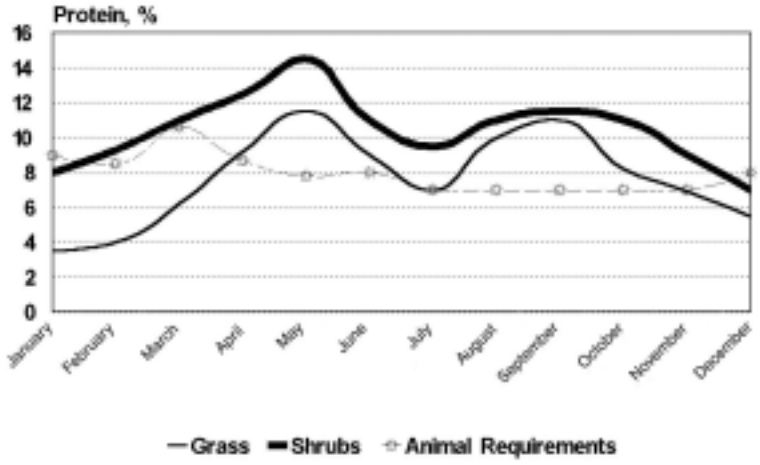
Cattle consumed more turbinella oak than they did ceanothus one year out of six, about the same for two

Figure 1. Phosphorus Nutritional Curve for Grasses vs. Shrubs



Generalized Curve for Arizona for an Average Year

Figure 2. General Nutritional Curve for Grasses vs. Shrubs With March Calving



Generalized Curve for Arizona for an Average Year

years of six, and much less turbinella oak than ceanothus three years out of six. The average turbinella oak consumption over the six years was 18.3% of the total diet, with a range in yearly percentage inclusion in the diet from 9.8 to 31.7%. Ceanthus consumption over the same time period averaged 24.9% with a yearly range of consumption from 14.9 to 34%. Over all months in the study, the range of turbinella oak consumption ranged from 0 to 73% and ceanothus consumption ranged from 0 to 65%.

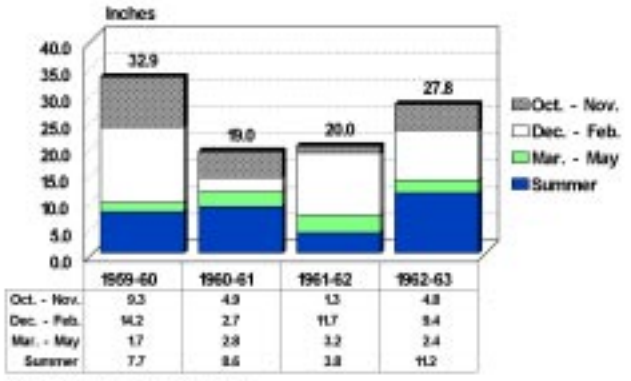
Given a choice, cattle will consume more perennial grasses and cool season annual grasses and forbs when they are actively growing and available. However, the shortage of herbaceous vegetation on browse dominated rangelands in Arizona necessitates the consumption of large amounts of shrubs for most of the year.

Nutritional Profile of Browse Species

When browse species are analyzed chemically for nutritional composition, they appear to have less phosphorus, crude protein, and energy than do forbs. When compared to grasses, most browse species appear to have greater phosphorus (Figure 1) and crude protein levels (Figure 2) than grasses most of the time, and greater than or equal energy levels most of the time. However, some browse species contain tannin compounds which ultimately make protein and energy less available for most classes of domestic livestock. The influence of tannins upon nutrition will be discussed in greater detail later.

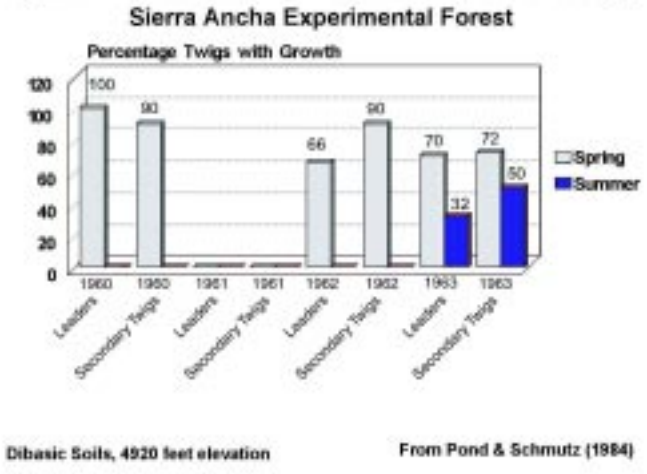
From Figures 1 and 2, it appears that browse species peak nutritionally in the early spring. The magnitude of this nutritional peak is dependent upon winter moisture. If little winter moisture occurs, then new twig mortality will occur, diluting the nutritional quality of the browse species. In explanation, animals will be forced to consume more low quality woody twigs as opposed to higher quality leaves. To illustrate, seasonal precipitation for the Sierra Ancha Experimental Forest near Roosevelt is shown in Figure 3 and corresponding twig growth and mortality in Figures 4 and 5. Leaders are new twig growth initiated each year and are recognized by the appearance of young, less woody tissue. Note that overall annual precipitation was similar for both 1960-61 and 1961-62, but that twig growth was lower and mortality

Figure 3. Seasonal Precipitation at Sierra Ancha



From Pond & Schmutz (1984)

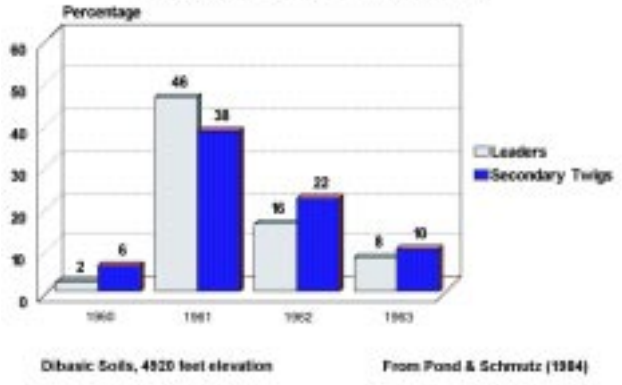
Figure 4. Growth of Turbinella Oak Twigs



Dibasic Soils, 4920 feet elevation

From Pond & Schmutz (1984)

Figure 5. Death of Turbinella Oak Twigs



Dibasic Soils, 4920 feet elevation

From Pond & Schmutz (1984)

higher when winter moisture did not occur. In fact, no new leader growth followed the dry winter in 1961 and 46% of existing leaders and 38% of existing secondary twigs grown in prior years died during this period of plant stress. It should be mentioned that there were no livestock present on this Experimental Forest.

Growth and death of twigs varied by browse species but the trend was similar to that observed for turbinella oak. Following the dry winter of 1961, there was no growth of either leaders or secondary twigs for any other shrub species. Also, a small (hollyleaf buckthorn and mountain mahogany) or large (desert ceanothus) percentage of twigs grown in previous years died during the spring of 1961.Tables 1 and 2 show the data for the major browse species measured over four years at the Sierra Ancha Experimental Forest.

Table 1. Percentage of Twigs with Growth by Year

Sierra Ancha Experimental Forest

Species	1960		1961		1962		1963	
	Leaders	Secondary	Leaders	Secondary	Leaders	Secondary	Leaders	Secondary
Hollyleaf Buckthorn								
Spring	_	_	0	0	88	94	66	68
Summer	_	_	0	0	0	0	0	0
Hairy Mountain Mahogany								
Spring	24	14	0	0	24	22	60	66
Summer	0	0	0	0	2	0	0	0
Desert Ceanothus								
Spring	92	68	0	0	72	78	84	92
Summer	0	0	0	0	0	0	80	90

From *The Arizona Chaparral: Its Growth and Nutritive Value*, **1984, Pond & Schmutz, University of Arizona.**

Table 2. Percentage of Twigs with Death by Year

Sierra Ancha Experimental Forest

Species	1960		1961		1962		1963	
	Leaders	Secondary Twigs	Leaders	Secondary Twigs	Leaders	Secondary Twigs	Leaders	Secondary Twigs
Hollyleaf Buckthorn	_	_	12	12	2	2	6	6
Hairy Mountain Mahogany	2	6	16	24	0	0	2	0
Desert Ceanothus	22	14	64	70	28	16	14	16

From *The Arizona Chaparral: Its Growth and Nutritive Value*, **1984, Pond & Schmutz, University of Arizona.**

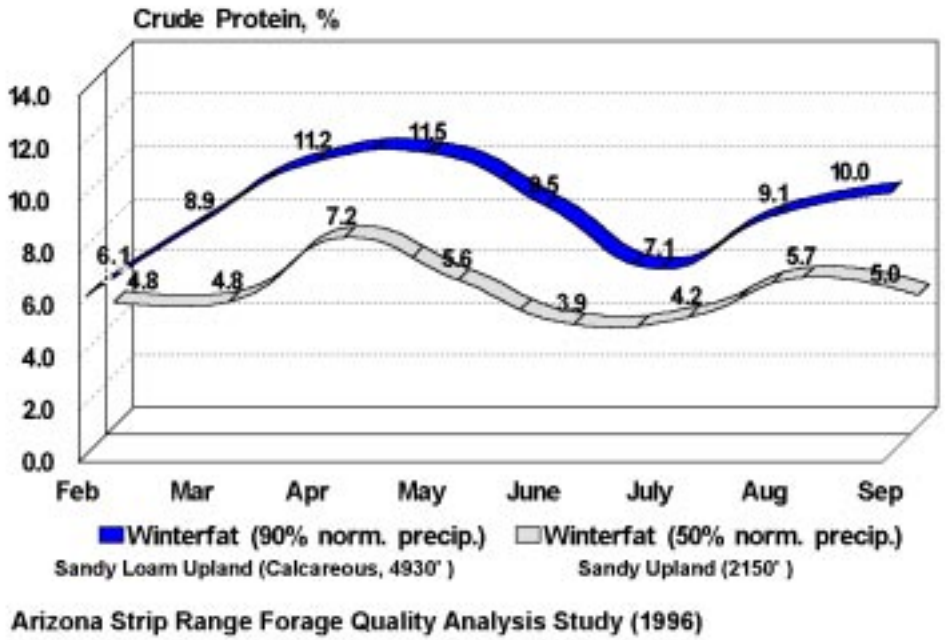
Drought and Its Effect Upon Nutritional Quality

Since shrubs store food in the stems as well as the roots, the portion of the plant available for browsing tends to hold nutritional quality better than do grasses during drought. *Grasses store food resources in the roots.* Still, drought will detrimentally affect forage quality of browse. Figure 6 compares crude protein content for clipped winterfat at two different range sites on the Arizona Strip during 1996. Although the two different range sites were of different soil types and elevation, we can draw conclusions about the availability of water and its effect upon crude protein. The crude protein in winterfat dropped with less precipitation. The nutritional quality of browse may not drop as low during drought as it does for grass, but levels will still decline below the nutritional requirements needed for livestock.

tannins are not usually digestible but indirectly affect animals by binding with protein and fiber, making the diet less digestible (Bederski, 1991; Reed, 1995). Condensed tannins can also bind with microbial digestive enzymes and make them ineffective (Makkar et al., 1988). Therefore, the ultimate effect of high condensed tannin concentrations is to make the animal both energy and protein deficient, causing reduced growth or weight loss and poor reproduction. When the total content of the diet contains 2% or greater total tannins, the diet is less palatable to the animal and the animal may experience toxicosis and possible death (Dr. Dick Rice, University of Arizona, retired, personal communication).

Arizona shrubs that have been identified to contain high levels of tannins include blackbrush, manzanita, and all the oak species. Blackbrush and manzanita are rarely ingested by grazing livestock, but turbinella oak

Figure 6. Example of Browse Crude Protein in Arizona During Drought



Effects of Tannins Upon Nutritional Quality

Tannins are defense compounds which exist in many shrubs. Tannins present in oak species have been used for many years to tan animal hides. The tannins contained in shrubs are mostly of two types, soluble and condensed (Bederski, 1991). Soluble tannins can be absorbed into the blood stream and can cause toxicological effects and death when concentrations in the diet are high. Condensed

can comprise large portions of the diet. Turbinella oak is the dominant species in the Arizona Interior Chaparral Grassland and may comprise up to 50% of the diet during some periods of the year (Ruyle et al., 1986).

Tannin content is highest when the shrub is rapidly growing and tannin poisoning can occur when young or inexperienced livestock consume immature buds in the spring. Tannin content can also increase following

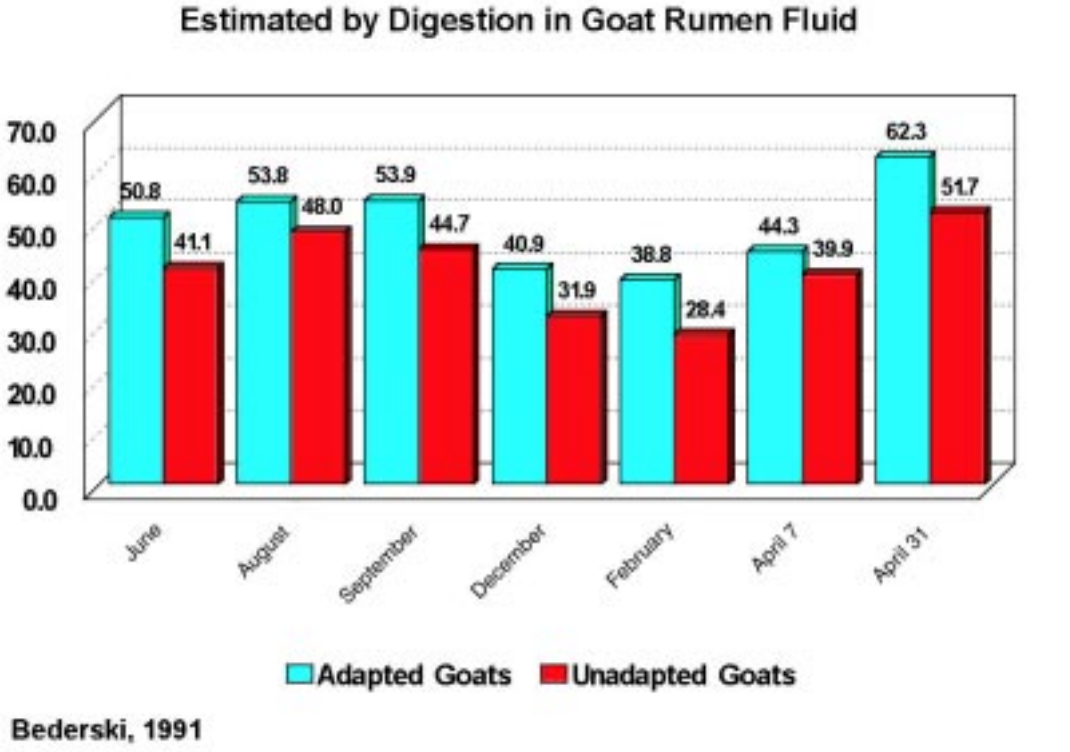
summer rains. Research reported by H. S. Gomes at the University of Arizona (1990) for turbinella oak concluded that condensed tannins are highest in the winter with immature leaves and that soluble tannins are highest in immature leaves in the summer through early fall. Maximum growth for turbinella oak in this study occurred from summer to early fall.

The symptoms of oak poisoning include dry, dark colored feces, depressed appetite, frequent urination, fluid accumulation in the chest and belly, and kidney failure (Kingsbury, 1964; Sandusky et al., 1977).

Two different sources (Kingsbury, 1964; Dollahite et al., 1966) established that oak poisoning occurs when the diet contains greater than 50% oak. It must also be assumed that subclinical effects such as decreased digestibility can occur when the diet contains smaller amounts of oak. Ruyle et al. (1986) reported that for oak-containing fecal samples examined by microscope for dietary content, 60 samples out of 438 total samples from cattle had at least 10% oak in the diet. About 42% of samples from this subset contained from 41 to 50% oak in the diet.

Using adapted animals can help counteract some of the effects of tannins in the diet. Adapted animals learn from past experience to avoid eating or to reduce the consumption of forage containing harmful toxins (Provenza, 1996). Adapted animals also develop some physiological adaptations to help counteract harmful toxicological effects of tannins. For example, the rumen microbes from adapted vs unadapted animals will differ (microbes break down cellulose and fiber consumed by ruminants). Figure 7 compares digestibility of turbinella oak for adapted and unadapted goats. Rumen fluid from both types of goats was obtained and immature ground-up urbinella oak leaves were placed in the rumen fluid, kept at a constant temperature and agitated frequently. At the end of 48 hours, the digestibility of the turbinella oak was estimated by the amount of sample remaining. Goats which had been adapted to the oak diet constantly had greater digestibility of the browse than did unadapted goats.

Figure 7. 48 Hour Rumen Digestibility of Immature Turbinella Oak Leaves



Counteracting the Effects of Tannins

Polyethylene glycol (**PEG**) is a nearly odorless and tasteless compound widely used in the food industry and in some water soluble lubricants. This compound has been found to be effective in tying up condensed tannins and preventing some of their negative effects. Table 3 reports findings by researchers wherein lambs were fed a diet containing 2.5% condensed tannins with or without added PEG at 40 grams per 2.2 lbs of food. Lambs receiving the diet with added PEG had significantly greater forage intakes and average daily gains than those receiving the control diet and had similar average daily gain to lambs receiving a corn and alfalfa hay diet.

Table 3. Using PEG to Counteract the Effects of Tannins

Lambs fed Tannin Diet Containing Carob Pulp with 2.5% Condensed Tannins.

	Tannin Diet w/o PEG	Tannin Diet with PEG	Corn & Alfalfa Diet
Dry Matter Intake, g/d	428	685	521
Nitrogen Digestibility, %	65.4	84.6	80.2
Avg. Daily Gain, g	48	140	135

Priolo et al., April 2000 Journal of Animal Science 78:810-816.

Although PEG appears to be efficacious in counteracting the harmful effects of condensed tannins, it does not appear to be cost effective for cattle at this time. Using a minimum dose used in some sheep studies of 12.5 grams and multiplying it by 7 for the larger cattle size would necessitate feeding 88 grams per day for cattle. At this time, shipping and freight to bring a commercial grade PEG from a supplier in West Virginia to Arizona increases the cost for a minimum 600 lb. order to $2.59 per lb. The cost per dose for cattle at the low dose of 88 grams would be $ 0.50 per day. At this cost, one could only afford to feed the PEG during short time periods when tannin levels in forage were high. A more cost effective procedure would be to feed around 3 lbs. per day of protein supplement at a cost of $ 0.27 per day during the same time period. Feeding the protein supplement would help counteract negative effects on protein digestibility (by providing additional protein) and provide some additional energy.

Another supplement which has been shown to be effective in helping prevent oak poisoning is to add calcium hydroxide to supplemental feeds at levels less than 10% (Dollahite et al., 1966).

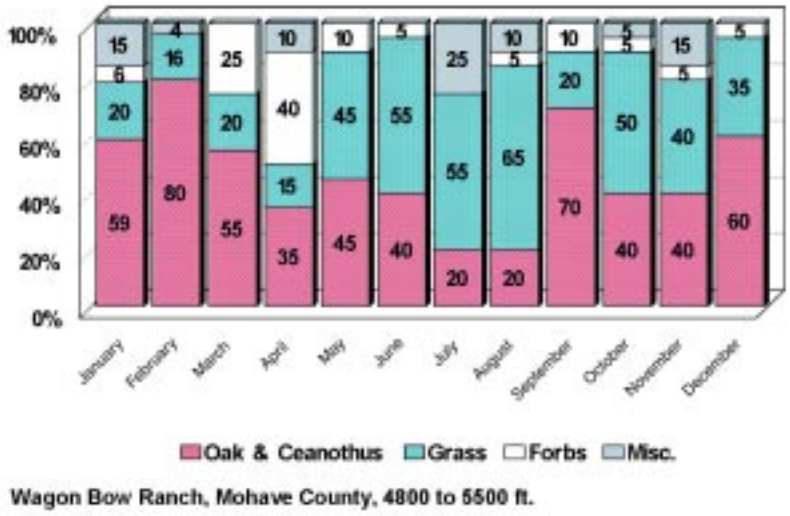
Diet Selection and Browse Utilization

In a study done in the Texas hill country and in South Texas, dietary selection of browse was tracked through the year (as reported in Lyons et al., 1996). Researchers found cattle had 1%, 4%, 15%, and 6% browse in the diet for spring, summer, fall, and winter respectively.

In a study done in the Wyoming Red Desert near Rock Springs, Wyoming, cattle consumed from 28 to 36% of the diet as browse in summer and from 33 to 34% as browse in the winter (Krysl et al., 1984). Dominant shrubs consumed were winterfat, fourwing saltbush, and gray horsebrush.

In the Arizona Interior Chaparral Grasslands in which the available forage is dominated more extensively by shrubs, the contribution to the diet by shrubs appears to be much greater than in the two previously cited studies. Figure 8 shows cattle dietary selection by month for different forage classes on a chaparral dominated ranch in Mohave County (unpublished data, Rob Grumbles, University of Arizona). The composition of the diet for each forage classification was estimated using microscopic analyses of fecal samples.

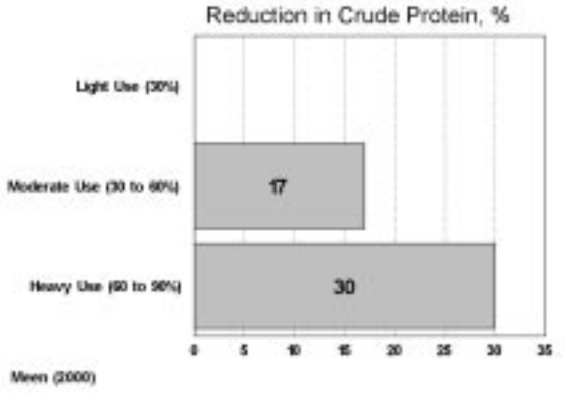
Figure 8. Browse in Cattle Diets by Month of Year



Wagon Bow Ranch, Mohave County, 4800 to 5500 ft.

Following monsoon rains, consumption of browse declined as perennial grasses became more available. During the winter with lesser amounts of grasses being available, the composition of the diet as browse was greater than 50%. From Bederski's research (Figure 7), we would expect the digestibility of the selected diet during winter to decline to levels below that needed for maintenance. [The digestibility or total digestible nutrients (**TDN**) of the diet needed to maintain a nonlactating cow is around 52%.] As in grasses, shrub digestibility declines with advancing maturity later in the season, though perhaps to a lesser extent. Another problem with shrubs is that much of the energy and protein consumed is contained in stems which are high in lignin. Although chemical analyses may show high digestibility for woody species, these chemical analyses may overestimate what the animal is actually able to digest. Browse species that are less woody in nature like winterfat are more digestible than are woody species such as turbinella oak.

Figure 9. Forage Quality of Fourwing Saltbush at Different Utilization Rates



With advancing season and extended time in pastures, livestock will not be able to select a high quality diet when shrubs are browsed more heavily. Figure 9 illustrates the effect of heavier utilization upon fourwing saltbush crude protein levels on the Arizona Strip.

As grazing pressure increases in browse pastures, livestock will spend more time searching for preferred forage, reducing forage intake. Ultimately, they will be forced to consume more stems and less leaves, diluting forage quality (Table 4). They may also consume less palatable species and possibly increase the intake of harmful secondary compounds contained in these less desirable browse species.

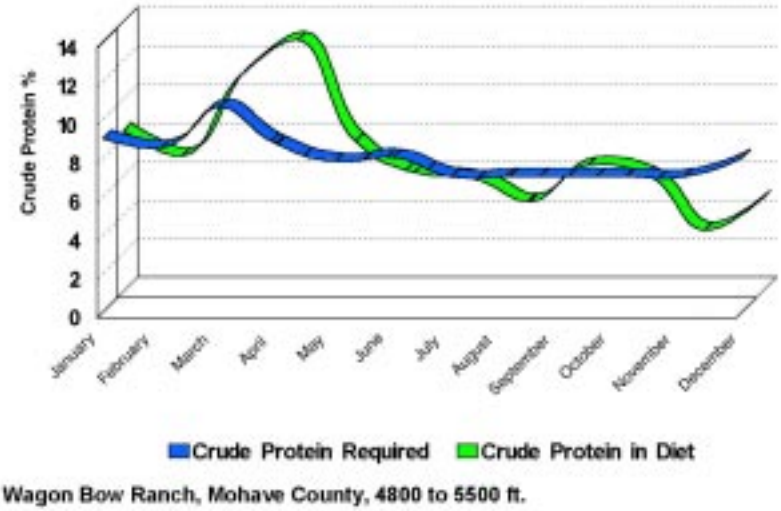
Table 4. Forage Quality of Shrub Twigs

Shrub	Crude Protein, %	Lignin, %
Stems	6.3	20.6
Leaves	13.0	12.3
Current Growth	11.6	15.0

From Cook and Harris (1950)

In Figure 10, the crude protein content of the diet consumed by cows on the Wagon Bow Ranch (Figure 8) is shown. As stated earlier, the diet selected by cattle was estimated using microscopic examination of cow fecal samples. Hand clipped samples of the respective forages chosen by cattle were then analyzed chemically to determine crude protein content of the diet consumed (estimated by multiplying forage chemical analyses crude protein contents by the percentage

Figure 10. Protein in Forage Consumed vs Protein Required by Cattle



estimated to have been consumed). No allowance for reduction in crude protein availability was made for tannin containing browse. The cows were deficient in crude protein in winter and in the summer preceding monsoon rains. The large peak in dietary crude protein in March and April was due to the consumption of globemallow, annual grasses (red brome), and annual forbs (particularly filaree).

Trace Mineral Concentrations in Browse

There is a scarcity of research regarding the concentration of trace minerals in browse. Sprinkle et al. (2000) compared the trace mineral status of shrubby buckwheat vs. cool season and warm season perennial grasses, annual grasses, and forbs at five times during the year in 1997-98 at a ranch near Globe. The trace minerals most commonly deficient in Arizona are copper, selenium, and zinc.

Shrubby buckwheat had lower copper concentrations than did forbs but was not different from perennial or annual grasses. The zinc content in shrubby buckwheat was less than in forbs, was not different from that found in warm season perennial grasses or annual grasses, but was greater than that found in cool season perennial grasses. The selenium content in shrubby buckwheat was greater than that found in cool season perennial grasses and annual grasses but did not differ from the selenium concentrations found in forbs or warm season perennial grasses. Copper was adequate most of the time in forbs, but marginally deficient in all other forage types. In all forage types measured, zinc appeared to be marginally deficient and selenium was deficient.

In the Arizona Strip Range Forage Quality Analysis Study (Meen, 2001), browse species evaluated (fourwing saltbush, winterfat, and white ratany) appeared to have greater levels of selenium, copper, and zinc than did the grasses. Selenium was adequate in browse and mostly adequate in grasses. Copper was severely deficient in grasses and moderately deficient in browse. Zinc was severely deficient in both grasses and shrubs, though shrubs had about twice the amount of zinc than did grasses.

Based upon the limited data we have at this time, it appears that the trend for browse in trace minerals is similar to that noted for phosphorus. That is, browse probably has higher concentrations of trace minerals than grasses, though not adequate to satisfy animal requirements year round. Concentrations of trace minerals in browse will vary by soil type just as it does for grasses.

Management

Since energy and protein content of browse decreases with advancing maturity and the advent of winter, cattle grazing browse dominated pastures are good candidates for winter protein supplementation (as are cattle in grass dominated ranges). If good quality browse species such as fourwing saltbush and winterfat are prevalent and are lightly (less than 40% utilization) grazed, cattle may be able to winter with minimal supplement provided. However, for ranges consisting of large percentages of oak species, protein supplementation during the winter is critically important.

If we assume the protein contained in diets with predominantly oak forage to be only 65% digestible (Table 3), then we can calculate the amount of crude protein which should be supplemented. If cattle consume 1.7% of body weight in forage and crude protein of the oak is 7%, and the cow weighs 1000 lbs. and is in the last trimester of pregnancy, then approximately 2 to 3 lbs. of a good quality natural protein supplement needs to be fed:

Example Calculation for Protein Supplementation

Cow Requirements: 1.6 lbs. crude protein (CP) per day

CP from diet: 17 lbs. forage x .07 protein x .65 digestible equals .77 lbs. CP from diet

Amount to supplement: 1.6 – .77 = .83 lbs. CP

Lbs. of 28% supplement to feed: .83 ÷ .28 lbs. CP/lb. supplement equals 2.96 lbs. of 28% CP supplement

Adjustment for moisture: 2.96 ÷ .90 dry matter = 3.29 lbs. of supplement needed

Some recommendations for protein supplements used on browse rangelands are that they contain at least 22% crude protein and that they be derived from natural protein sources (no urea). There are two reasons urea based supplements should not be used on browse rangelands: 1) for rumen microbes to effectively process urea they need an easily digestible source of energy (which many browse species are not); and 2) to break down the urea molecule and process the excess nitrogen requires additional energy input from the ruminant animal. For more information on protein supplementation see Arizona Cooperative Extension Publication # AZ1186 *Protein Supplementation* (Sprinkle, 2000a).

In the Wagon Bow example shown above in Figures 8 and 10, there are two critical time periods for supplementation.

The most important time period is in the winter. If the cow is not supplemented at this time period, weight loss before calving will accelerate and will compromise reproductive efficiency after calving. Almost all range cows will lose some weight during the first 45 to 60 days of early lactation. If weight loss before calving is stacked on top of early lactation weight loss, then the period after calving prior to conception will lengthen. In the Wagon Bow example, protein would need to be supplemented at least three months during the winter. If protein were not supplemented during December, January, and February when crude protein of the diet is moderately to severely deficient, weight loss of cattle in the last trimester of pregnancy would be severe. Protein supplementation for three months would probably cost somewhere around $25 to $35 per cow.

The other time period to consider supplementation is in the "summer slump" period preceding monsoon rains. It may be possible to coast through this time period without supplementation if the calving season is properly timed with the forage quality and quantity nutritional curve. If cattle on the Wagon Bow Ranch in the above example calved in early March, they may be able to replenish body stores prior to the start of breeding. Calves in this example would be born just as nutritional quality is peaking. Granted, if the spring was dry and no annuals were present, there would be a problem with cow body condition. However, looking at the data from the Wagon Bow Ranch, there does not appear to be any other time of the year in which there is a chance for a large increase in forage quality. The second best time to calve would probably be at the start of monsoon rains, but this would produce a lightweight calf at weaning.

It is a good idea to look at the forage quality and quantity curve for your ranch and try to match calving season to fit the curve. Forage samples can be obtained to help determine when forage quality is at its best. For chaparral dominated ranges, a juggling act must be done to try to prevent calving or having early lactation cows in pastures dominated by oak brush. Not only is the chance for oak poisoning higher in early spring but the browse dominated pastures also provide more cover for predators. Having a few open pastures available for cows when they calve will enhance nutritional quality and aid in preventing weight loss prior to breeding.

To determine how well you are doing in meeting the cow's nutritional requirements with your management system, closely monitor cow body condition prior to and after calving. By combining protein supplementation with body condition score monitoring on the cowherd and matching calving with the forage curve, some of the challenges of ranching in browse rangelands can be overcome. For more details on body condition scoring and supplementation, see Arizona Cooperative Extension Publication # 195023 (Sprinkle, 1995) which can be found at ag.arizona.edu/pubs/animal/az9523.pdf.

For more tips, see Arizona Extension Publication #AZ1166 *Managing Nutritional Challenges to Reproduction* (Sprinkle, 2000b).

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