Seasonal Nutrient Estimates of Mule Deer Diets in the Texas Panhandle

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Abstract

Botanical composition and estimated seasonal nutrient quality of mule deer *(Odocoileus hemionus)* diets from the Canadian River and Clarendon areas of the Texas Panhandle were determined from 1979 to 1980. Deer from the Canadian River area consumed annually 62% browse, 34% forbs, 1% grasses, and 3% unknowns. Deer from the Clarendon area averaged 56% browse, 28% forbs, 11% grasses, and 5% unknowns annually. Deer consumed more grass at Clarendon because they had access to cultivated small grains, primarily winter wheat and rye. Annual deer diets from the Canadian River area contained 8±1% crude protein (CP), 0.14±.03% phosphorus (P), and 47±2% in vitro organic matter digestibility (IVOMD). Deer diets from the Clarendon area averaged 10±3% CP, 0.15±.03% P, and 50±2% IVOMD annually. Higher nutrient quality of mule deer diets at Clarendon suggests cultivated small grains/legumes have excellent potential to enhance Texas Panhandle deer herds that normally subsist on a fair to poor nutritional plane.

Mule deer are one of the more important big game animals in the Texas Panhandle. Ranchers who have mule deer on their property can supplement their incomes through legal harvest of these game animals. However, the habitats support relatively low density populations and an inadequate food base of poor nutrient quality has been cited as a possible limiting factor (Wiggers 1983).

Most studies of forage quality on western deer ranges have concentrated on winter range, especially in the Rocky Mountain region. However, some studies indicate nutritional levels in summer diets to appear to influence reproductive success (Swank 1958, Julander et al. 1961, and Hungerford 1965). A year-long evaluation of deer range provides a greater data base to plant vegetation-modification programs for deer habitat improvement, assess impacts of other land management activities, and develop more comprehensive deer range condition surveys (Urness and McCulloch 1973).

Our objective in this study was to identify plants that comprise the annual food base for deer and to evaluate the nutrient content of mule deer diets from 2 different habitats in the Texas Panhandle.

Study Area

Research was conducted on 2 sites in the Texas Panhandle. The Canadian River area was on the Masten and Spring Creek ranches in Oldham and Hartley counties (Fig. 1). The Clarendon area, approximately 100 km southeast was located on the Triple L, Haegy, and J.A. ranches in Donley and Armstrong counties (Fig. 1).

Topography of the Canadian River study area was level to rolling, broken by rough breaks of the Canadian River and the Minneosa and Trujillo Creeks. Elevations varied from 976 to 1,281 m. Soils are deep sands, sandy loams, and loams with outcrops of Permian Red Beds in the river breaks. Average annual precipitation is 50 cm (SCS 1980a). Four vegetation types—juniper breaks, mesquite/shortgrass, sand sagebrush, and catclaw acacia/yucca—cover most of the area and has been described by Koerth (1981).

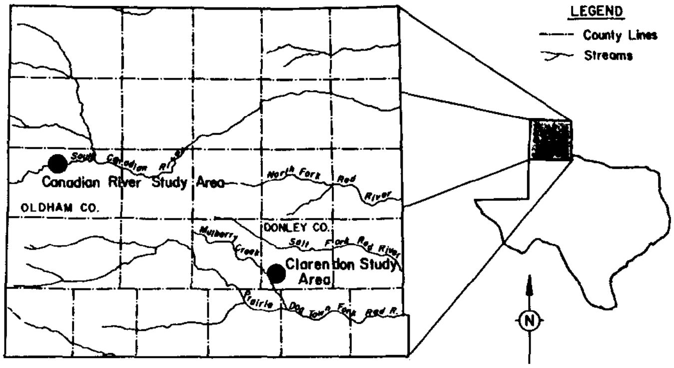

Fig. 1. *Location of study area in the Texas Panhandle.*

Topography at Clarendon is rolling but also contains steep canyons of the many small tributaries of Mulberry and Troublesome Creeks. Elevation varies from 700 to 900 m. Soils are loamy sands or sandy loams. Average annual precipitation is 54.0 cm (SCS 1980b). The Clarendon site differs from the Canadian River site in 2 respects. First, most deer at Clarendon have access to wheat/rye fields while deer at the Canadian River study area did not. Secondly, Clarendon has juniper/mesquite and more extensive riparian zones, in addition to the 4 vegetation types found at the Canadian River site (Koerth 1981).

Scientific nomenclature for grasses followed Gould (1975). Scientific nomenclature for forbs and browse followed Correll and Johnston (1970).

Methods

Fifteen mule deer fecal groups, usually less than 4 hr old, were collected monthly from each study area from August 1979 to July 1980. Microscopic slides of reference and fecal material were prepared after Free et al. (1970). Microhistological examination of samples followed procedures outlined by Sparks and Malechek (1968). Twenty fields each on 5 microscopic slides were examined at 100x magnification. Relative density of plant species in the diet was calculated for each month and averaged across the following seasons: winter (December–February), spring (March–May), summer (June–August), and fall (September–November). Half-shrub sundrop *(Calylophus serrulatus)* and trailing ratany *(Krameria lanceolata)*, normally considered as half-shrubs, were included in the browse category.

Composite samples of individual plant species used by mule deer were obtained each month by hand harvesting from 20 or more randomly selected plants. Plant parts (leaves and new-growth twigs) were selected to simulate observed mule deer grazing behavior. All samples were air dried in a forced-air oven at 60°C for 48 hr, ground in a Wiley mill to pass a 40-mesh screen and stored in air-tight jars.

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Crude protein (CP) was determined for composite samples of each plant species using the micro-kjeldahl method of Ocherman (1971). Percent phosphorus (P) was determined using AOAC (1970) procedures. In vitro organic matter digestibility (IVOMD) was determined by procedures outlined by Van Soest (1970), who modified the Tilley-Terry two-stage technique (Tilley and Terry 1963). The technique for evaluating each sample was a 48-hr in vitro digestion with inocula from a steer on an alfalfa *(Medicago sativa)* diet, followed by extraction in neutral detergent (Van Soest and Wine 1967). Palmer et al. (1976) concluded cattle as an inoculum source could be used to accurately estimate digestibilities of deer foods. Percent organic matter content was determined by ashing duplicate samples at 550° C for 4 hr. Digestible energy (DE) was estimated by multiplying the IVOMD coefficient, corrected from IVOMD of a standard forage of known in vivo digestibility, by 4.0 kcal/kg (Bryant et al. 1980).

Most plant species were analyzed for CP and P each month, and the seasonal estimates for those constituents were obtained by averaging all monthly values. We were not always able to collect samples for each plant species every month; therefore, a single month or an average of 2 months' values was sometimes used to represent the seasonal estimate. Seasonal IVOMD estimates were obtained by analyzing plant species which were collected in the month having the greatest relative frequency in deer diets.

Since nutrient intake could not be measured directly, the average percent a plant species contributed to seasonal diets was multiplied by its chemical content to provide an estimate of the weighted nutritional value of that species, similar to procedures of Urness and McCulloch (1973). To estimate the nutrient content of seasonal mule deer diets, weighted values for each nutrient were summed across species and divided by the percent of the total diet accounted from plants analyzed for nutrient content.

Results and Discussion

Botanical Composition

Fecal analyses of 180 samples from the Canadian River area indicated 76 plant species were consumed by mule deer. The average annual diet contained 62% browse, 34% forbs, 1% grasses, and 3% unknown (Table 1). Skunkbush sumac *(Rhus aromatica)* was the most abundant plant species identified in fecal samples from the Canadian River area.

An identical number of fecal samples from the Clarendon area indicated 83 plant species were ingested by mule deer. The annual diet consisted of 56% browse, 27% forbs, 11% grasses [9% was wheat *(Triticum aestivum)* and rye *(Secale cereale)*], and 5% unknown (Table 1). Half-shrub sundrop was the major plant species identified in samples from Clarendon.

The use of fecal examination to determine diets does have limitations. Storr (1961) and Stewart (1967) stated plants with high lignin content tend to be overestimated whereas ephemeral plant species tend to be underestimated using this technique. Thus, seasonal skunkbush sumac values may have been exaggerated because it is a woody browse species. Forb values obtained in this study were probably underestimated. Although exact percentages derived

Table 1. Botanical composition of major plant species (mean %) found in mule deer diets from two areas of the Texas Panhandle (1979–1980).

	Season of Year									
	Spring		Summer		Fall		Winter		Annual	
Forage	CR[a]	C[a]	Cr	C	CR	C	CR	C	Cr	C
Browse:										
Rhus aromatica										
Skunkbush sumac	16	8	42	26	43	14	10	2	28	13
Juniperus sp.										
Redberry or one-seed juniper	3	9	1	2	7	7	15	27	6	11
Artemesia filifolia										
Sand sagebrush	24	5	—	1	1	—	5	—	8	2
Calylophus serrulatu										
Half-shrub sundrop	8	15	20	16	11	24	4	12	11	17
Kramaria lancolata										
Trailing ratany	3	2	11	11	4	5	1	1	5	5
Cercocarpus montanus										
Mountain mahogany	T[b]	2	T	6	T	4	T	1	T	3
Others	2	6	5	5	4	6	5	2	4	5
Subtotal	56	47	79	67	70	60	40	45	62	56
Grasses:										
Triticum sp./*Secale* sp.										
Wheat/rye	—	4	—	—	—	5	—	27	—	9
Others	T	1	1	T	2	5	T	4	1	2
Subtotal	t	5	1	T	2	10	T	31	1	11
Forbs:										
Artemisia ludoviciana										
White sage	5	2	2	5	11	3	7	2	6	3
Lesquerella spp.										
Bladderpods	5	4	—	T	T	1	11	1	4	1
Polygala alba										
White milkwort	3	4	—	—	2	1	2	1	2	2
Others	27	33	16	22	13	21	33	13	22	22
Subtotal	40	43	18	27	26	26	53	17	34	28
Unknown:	4	5	2	6	2	4	7	7	3	5
Total	100	100	100	100	100	100	100	100	100	100

[a]CR - Canadian River C - Clarendon
[b]T - Trace (< 1%)

Table 2. Estimated seasonal nutrient quality (± Standard Error) of mule deer diets from two areas in the Texas Panhandle (1979–1980)[a].

	% Diet Tested		% Dry Matter Crude Protein		% Dry Matter Phosphorus		% IVOMD		Est. DE supplied to a 55 kg deer consuming 1.2 kg of forage/day	
	CR	C	CR	C	CR	C	CR	C	CR	C
Spring	84	82	10 ± 1	13 ± 1	0.17 ± .02	0.20 ± .02	48 ± 3	54 ± 2	2304 ± 141	2592 ± 82
Summer	89	82	7 ± 2	8 ± 1	0.14 ± .02	0.13 ± .03	49 ± 1	43 ± 3	2352 ± 129	2064 ± 125
Fall	88	77	7 ± 1	8 ± 1	0.12 ± .02	0.09 ± .02	43 ± 3	46 ± 4	2064 ± 111	2208 ± 178
Winter	61	75	7 ± 1	11 ± 2	0.12 ± .03	0.17 ± .02	47 ± 5	58 ± 4	2256 ± 228	2784 ± 198
Annual	81	79	8 ± 1	10 ± 1	0.14 ± .03	0.15 ± .03	47 ± 2	50 ± 2	2244 ± 78	2412 ± 81
optimum requirements			16		0.30–0.50					
minimum maintenance req.			7		0.15		1740[b]			

[a]CR - Candian River Area C – Clarendon Area
[b]Derived from 70 kcal $kg^{.75}$ × 1.23 (Activity metabolic rate)

from this technique are questionable, Vavra et al. (1978) demonstrated relative importance ranking of individual species is comparable to esophageal methods.

Mule deer diets in the Guadelupe Mountains National Park, Texas, averaged 77% browse, 21% forbs, and 2% grass (Krysl 1979). Boeker et al. (1972), using rumen analyses, demonstrated mule deer in southwestern New Mexico consumed 75% browse, 16% forbs, and 2% grass. Thus, mule deer diets in this study used less browse and more forbs annually than deer reported from other Southwest ranges. This high forb consumption is particularly surprising because the forb standing crop is scant compared to mule deer habitats in the Trans-Pecos region of Texas (Wiggers 1983).

Kufeld et al. (1973) found Rocky Mountain mule deer diets averaged 57% browse, 28% forbs, and 15% grass annually over their entire range. Our results were similar to Kufeld et al.'s. (1973), even though habitats on the Canadian River and Clarendon appear to lack the large browse component present on other mule deer ranges in adjacent areas (Boeker et al. 1972, Bird and Upham 1980, Krysl et al. 1980).

Estimates of Nutrient Content of Mule Deer Diets

Crude Protein

Seasonal CP estimates from the Canadian River ranged from 10±1% in the spring to 7±2% for the other seasons (Table 2). Crude protein estimates from Clarendon varied from 13±1% in the spring, 8±1% through the summer and fall, to 11±2% in the winter (Table 2). Higher winter and spring crude protein values at Clarendon were attributed to greater deer use of wheat/rye, half-shrub sundrop and trailing ratany.

Our estimates of CP in mule deer diets were lower than other estimates obtained in desert habitats. Short (1977) reported mule deer diets on the Santa Rita Experimental Range, Arizona, ranged from 9.6 to 10.4% CP. Urness et al. (1971) found mule deer diets from the Three Bar Wildlife area in Arizona averaged 12% CP throughout the year, higher than either of our areas (Table 2). Mule deer diets from Fort Bayard, N. Mex., averaged 10% CP annually (Boeker et al. 1972), equal to the Clarendon area, but 2% higher than the annual estimate from the Canadian River area (Table 2). Seasonal CP in the diets of Rocky Mountain mule deer appears to be higher in the summer (18%) but as low or lower (6–8%) in the fall and winter (Wallmo et al. 1977, Urness et al. 1971) than our estimates.

Annually, 12% CP in the diet is considered adequate for growth and reasonable reproduction of deer, although 6 to 8% CP is considered adequate for maintenance and to support rumen functions (Dietz 1965). Approximately 16–18% crude protein in the diet should serve the optimum requirements for deer (Verme and Ullrey 1972). Crude protein estimates from our study areas appear to be adequate for maintenance, but were below optimal levels in every season except spring (Table 2).

Grazing animals usually select plants which are higher in nutrient composition than plants which are harvested by hand (Edlefsen et al. 1960, Campbell et al. 1968). Therefore, our seasonal estimates of crude protein, phosphorus and digestible energy probably represent the minimum levels of ingested nutrients.

Phosphorus

Estimates of P in the diets were highest in the spring (0.17±.02%) and lowest (0.12±.02%) in the fall and winter on the Canadian River. At Clarendon, P also was highest in the spring (0.20±.02%) and lowest in the fall (0.09±.02%) (Table 2). Skunkbush sumac and half-shrub sundrop were the major annual contributors of P to mule deer diets from the Canadian River area, although sandsage *(Artemisia filifolia)* was the largest contributor in the spring. Skunkbush sumac and half-shrub sundrop contributed most of the P to diets from the Clarendon area in every season except winter, when the use of wheat/rye and juniper (*Juniperus* sp.) increased.

Other studies conducted in desert habitats found P estimates greater than ours in almost every season (Urness et al. 1971, Boeker et al. 1972, Urness and McCulloch 1973, and Short 1977). Our lower values on both areas, especially in the summer and fall, were the result of increased use of skunkbush sumac and half-shrub sundrop (Table 1), which contained less P (0.09%) during these seasons (Sowell 1981).

Short (1981) has suggested that dietary P levels should be approximately 0.20–0.25%, and calcium should be no greater than 1 to 5 times the P level. Mature white-tailed deer require between 0.3 and 0.5% dietary P for optimal metabolic needs (Brown 1978) and between 0.16 to 0.25% for maintenance requirements (Dietz 1965). Short (1981) suggested that calcium levels in western range vegetation are usually adequate, but most problems which occur are related to the high calcium levels in the vegetation combined with very low phosphorus values. Calcium levels were not examined in this study.

In vitro Digestiblity

Percent IVOMD estimates in mule deer diets from the Canadian River area were lowest in the fall (43±3) and highest in the summer (49±3) (Table 2). Except for the summer, IVOMD estimates from the Clarendon area were usually greater than those from the Canadian River area, and ranged from 58±4% in the winter to 43±3% in the summer (Table 2). The high winter value from the Clarendon area was due to deer use of wheat/rye (27% in the diet), which was highly digestible (89%) (Sowell 1981).

Several studies have examined the digestibilities of mule deer forages (Urness et al. 1971, Boeker et al. 1972, Urness and McCulloch 1973, and Short 1977) on an in vitro dry matter disappearance basis. Our digestibilities were examined from an organic matter disappearance basis (IVOMD), and are therefore not directly comparable.

Digestible Energy

Since digestibility coefficients do not provide nutritional value of forages directly, researchers (Bryant et al. 1980, Wallmo et al. 1977) have converted these numbers into kcal/kg in an attempt to estimate the energy content of a particular forage.

Energy requirements for deer have been estimated (Moen 1973). Basic metabolic rate (BMR) of a penned deer in a thermalneutral environment is approximately 70 kcal per day per kg of metabolic body weight ($BW^{.75}$). Moen (1973) also estimated that free-roaming deer usually require 1.23 to 1.98 times the BMR, often called activity metabolic rate (AMR).

Theoretically, increased energy demands could be compensated for by increased food intake, however, deer have a limited intake capacity that hampers their ability to make up energy deficits by increasing forage intake (Amman et al. 1973). Nichol (1938) estimated daily dry matter intake of penned mule deer was approximately 22 g/kg body weight (BW).

To evaluate our digestible energy (DE) levels with respect to minimum requirements, we standardized all values to a common-sized animal and assumed that an average doe from either study area weighed 55 kg and consumed about 1.2 kg (22 g/kg BW) of forage per day. Therefore, all seasonal DE estimates (Table 2) were adjusted for intake. Minimum energy levels of a 55 kg deer were derived using an AMR (1.23) to correct Moen's (1973) formula for BMR (Table 2). Using these adjusted figures, DE levels in diets from both areas appear to be adequate, but were lower in the summer and fall (Table 2).

Studies of white-tailed deer *(O. virginianus)* in central Texas (Taylor and Hahn 1947, Teer et al. 1965) found that malnutrition frequently occurred late in summer when drought was most common. Recently, Bryant et al. (1980) reported white-tailed deer on the Edward's Plateau of Texas were energy deficient in summer and winter. A summary by Urness (1981) concluded that the nutritional plane of mule deer in desert and semidesert habitats seldom falls as low as that of Rocky Mountain mule deer in the winter and that it does not rise as high in the summer. This may protect deer in the Southwest from mass starvation suffered by northern deer, but it may also suppress their productivity (Urness 1981). Our low summer and fall DE values suggest a potential negative effect on herd productivity in the Texas Panhandle.

Conclusions

Seasonal estimates of nutrient factors for both areas were generally greater in the spring and winter than other seasons. Higher nutrient values in the spring would be expected; however, elevated values in the winter were not. Due to warming trends in February, however, the weather was favorable to forb production. Deer from the Canadian River area consumed 53% forbs in winter, which were generally higher in CP, P, and IVOMD than other forage classes (Sowell 1981). Deer from the Clarendon area consumed 27% grasses in the winter (mostly wheat/rye), which were very high in CP, P, and IVOMD. Our methods of collected forae samples probably resulted in minimum nutrient estimates, but it is reasonable to suggest mule deer were on a fair to poor nutritional plane.

Critical periods of nutritional stress for mule deer would be late gestation, early lactation, and prior to ovulation for the doe (i.e., spring and fall). Mule deer fawns would be under the most nutritional stress during lactation and weaning. Low nutritional estimates of CP, P, and IVOMD in the spring, summer, and fall from both areas suggest mule deer in the Texas Panhandle are receiving inadequate nutrition when requirements for reproduction are greatest. Planting supplemental feeds such as wheat/rye for the fall and winter, legumes for spring, and forage sorghums for summer seems a practical method of improving the nutritional quality of mule deer diets in the Texas Panhandle, especially since deer readily use cultivated fields (Koerth 1981).

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