Estimating Seasonal Diet Quality of Pronghorn Antelope from Fecal Analysis

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Abstract

Botanical composition of pronghorn antelope diets from fecal analysis and nutrient quality of samples of plants known to be used by pronghorn were evaluated from June 1979 to May 1980 in Oldham and Hartley counties of the Texas Panhandle. Pronghorn in this area consume forbs primarily throughout the year, followed by browse and grasses. Pronghorn exhibited an affinity for either *Artemisia ludoviciana* or *Sphaeralcea coccinea,* or both, in all seasons. Grass use was negligible. Seasonal crude protein estimates ranged from a low of 9.8% in winter to a high of 11.4% in spring. Estimates of phosphorus were lowest in winter (0.15%) and highest in spring (0.18%) corresponding to rapid plant growth. Digestible energy levels were lowest in the fall, approaching 2,227 kcal/kg, and highest in spring and summer, 2,656 and 2,631 kcal/kg, respectively. Average in vitro digestible organic matter coefficients for spring, summer, fall, and winter were 69%, 67%, 53%, and 61%, respectively. The combination of fecal analysis for botanical composition and nutrient content from samples of plants known to be ingested provides at least an estimate of nutrient content of the diet.

Evaluating the quality of a habitat for ungulates requires estimates of nutrient supply from the vegetation complex. For free-ranging wild ungulates like pronghorn antelope *(Antilocapra americana)*, gross estimates must sometimes be substituted where use of refined techniques are limited. Chemical analyses of plants collected from uneaten forage usually accompany some estimate of the diet. Smith and Malechek (1974) estimated pronghorn diets using ocular estimates of forage removed by free-ranging pronghorns and subsequently hand-picked samples and composited by weight those plants consumed for later chemical analyses. Schwartz et al. (1977) hand-picked plant samples to duplicate observations of tame pronghorn and attempted to estimate dietary nutritional content from mean bite-weight. The objective of this study was to evaluate nutrient content of pronghorn diets from known botanical diet composition using fecal analyses, and nutrient consumption of herbages determined from hand-harvested samples.

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Study Area

The study area included 1,821 ha on the Masten and Spring Creek ranches in Oldham and Hartley counties of the Texas Panhandle. Topography was level to rolling, broken only by the Canadian River and its tributaries. Elevations varied from 976 to 1,281 m. Soils in the area were deep sands, sandy loams, and loams with small exposures of Permian Red Beds along the Canadian River. Average annual precipitation was 49.5 cm (Soil Conservation Service 1980).

Four vegetation types, juniper breaks, mesquite/shortgrass, sand sagebrush, and catclaw acacia/yucca, cover most of the area and have been described by Koerth (1981). The study was grazed continuously, yearlong by cattle at moderate stocking levels. All vegetation types also were used by mule deer *(Odocoileus hemionus).*

Nomenclature for grasses follows Gould (1975) whereas, nomenclature for forbs and browse follows Correll and Johnston (1970).

Methods

Botanical Compostion of Diet

From observed defecations of pronghorn, fecal pellets were collected monthly from June 1979 through May 1980. Samples (approximately 20 grams each from 43–57 single defecations/season) were preserved in 95.0% ethanol prior to examination. Microscopic slides of reference and fecal material were prepared as

described by Free et al. (1970). Microhistological examination of samples followed procedures outlined by Sparks and Malechek (1968). Five microscopic slides were made from each sample and 20 fields/slide 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).

Nutrient Composition

Composite samples of individual plant species used by pronghorn were obtained each month by hand-picking from 20 or more randomly selected plants. Plant parts (leaves and new growth twigs) were selected to simulate pronghorn 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.

Percent nitrogen was determined for each composite plant sample using the micro-Kjeldahl method of Ocherman (1971). Percent phosphorus was calculated using standard A.O.A.C. (1970) procedures. In vitro organic matter digestibility (IVOMD) was determined by procedures outlined by Van Soest (1970), who modified the Tilley-Terry 2-stage technique (Tilley and Terry 1963). The technique was a 48-hr in vitro digestion with inocula from steer fed alfalfa *(Medicago sativa)* hay, followed by neutral detergent to extract all available organic matter. Percent organic matter content was determined by ashing duplicate samples at 550° C for 4 hr. Digestible energy was estimated by multiplying the IVOMD coefficient, corrected from IVOMD of a standard forage of known in vivo digestibility, by 4,000 kcal/kg.

Problems were encountered in trying to estimate nutrient content of each species found in the diet. Within a season, we sometimes were unable to collect samples every month of each plant species. Thus, a single month's nutrient value for a plant sometimes was used to represent the chemical content of the species for the entire season. When more than one monthly sample was collected within a season for a particular plant, we used the highest monthly value of nutrient content found for that season. Last, for some species found in the diet, we were unable to collect a sample for chemical analysis because search time proved to be prohibitive.

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 pronghorn diets, weighted values for each nutrient were summed across species and divided by the percent of the total diet accounted for from plants analyzed for nutrient content.

Results and Discussion

Botanical Composition

Yearlong, pronghorn diets were comprised of 57% forbs, 38% browse, 3% grass and sedges, and 2% unknown (Table 1). That forbs dominated the diets agrees with data from Texas (Buechner 1950), Alberta (Mitchell and Smoliak 1971), and eastern New

Table 1. Vegetation (mean %) making up 2% or more of a seasonal diet for pronghorn in the Texas Panhandle.

Forage	Season of Year				
	Spring (43)[a]	Summer (43)	Fall (57)	Winter (46)	Annual (189)
Grasses:					
Blue grama *(Bouteloua gracilis)*	2.5	1.1	1.1	T	1.3
Others	2.0	1.5	T	1.1	1.2
Subtotal	4.5	2.6	1.4	1.3	2.5
Forbs:					
Scarlet globemallow *(Sphaeralcea coccinea)*	12.1	14.6	12.3	3.0	10.5
Bladder pods (*Lesquerella* sp.)	10.2	—	2.9	13.2	6.6
Whitesage *(Artemisia ludoviciana)*	8.6	7.3	9.7	5.1	7.7
Mentzelia *(Mentzelia nuda)*	4.9	3.1	2.9	10.6	5.4
Wooly plantain *(Plantago patagonica)*	2.9	3.6	1.7	1.9	2.5
Plains Zinnia *(Zinnia grandiflora)*	2.7	1.0	T[b]	T	T
Ragweed *(Ambrosia psilostachya)*	1.5	6.5	2.9	1.7	3.2
Texas croton *(Croton texensis)*	T	6.5	10.8	3.4	5.3
Plains blackfoot *(Melampodium leucanthum)*	1.9	3.1	3.4	3.0	2.9
Buckwheat (*Eriogonum* sp.)	1.5	2.7	1.9	1.9	2.0
Ratany *(Krameria lanceolata)*	T	2.3	1.4	1.1	T
Gaura (*Gaura* sp.)	T	2.0	T	T	T
White milkwort (*Polygala alba)*	1.5	—	—	2.3	T
Others	3.4	12.5	8.9	12.2	9.3
Subtotal	50.7	58.2	59.4	60.9	57.3
Browse:					
Half-shrub sundrop *(Calylophus serrulatus)*	17.9	19.9	14.7	9.6	15.5
Sand sagebrush *(Artemisia filifolia)*	15.1	2.6	13.5	20.3	12.9
Skunkbush *(Rhus aromatica)*	5.0	6.3	3.9	1.5	4.2
Feather dalea *(Dalea formosa)*	T	3.7	T	—	1.3
Honey mesquite *(Prosopis glandulosa)*	—	3.0	2.4	—	1.4
Perennial broomweed *(Xanthocephalum sarothrae)*	1.2	T	—	4.9	1.6
Others	1.0	T	T	—	T
Subtotal	40.3	36.7	37.4	36.6	37.7
Unknown:	4.5	2.5	1.8	1.2	2.5
TOTAL	100.0	100.0	100.0	100.0	100.0

[a]Number of samples
[b]T = Traces (<1.0%)

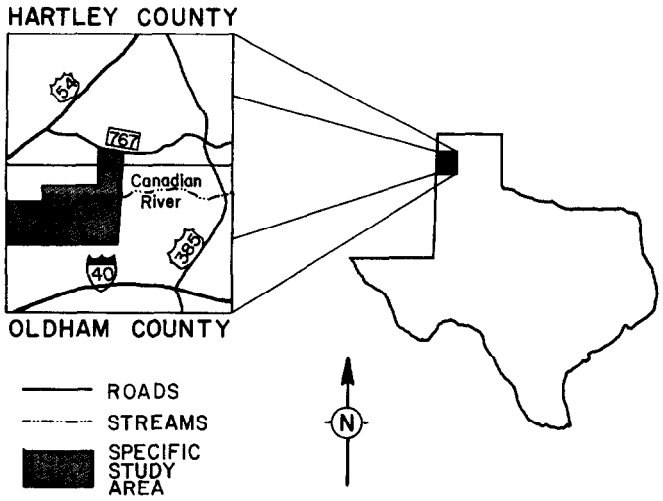

Fig. 1. *Study area location in the Texas Panhandle.*

Mexico (Beasom et al. 1982). From pronghorn antelope habitats in Saskatchewan (Dirschl 1963), Oregon (Mason 1952), and Utah (Beale and Smith 1970) browse played the dominant role in the annual diet of pronghorn. The negligible use of grass by pronghorn in our study agrees closely with results from Texas (Buechner 1950), New Mexico (Beasom et al. 1982), Oregon (Mason 1952), and Utah (Beale and Smith 1970), but differs from data of Schwartz and Nagy (1976) in Colorado and Hlavachick (1968) in Kansas, who found pronghorn used considerably more grass. In Colorado, grass-dominated annual pronghorn diets were attributed to a grass-dominated available forage (Schwartz and Nagy 1976).

Seasonal consistency in pronghorn use of forbs (50–60%) and browse (36–41%) (Table 1) agreed with findings from a similar habitat in eastern New Mexico (Beasom et al. 1982). However, pronghorns from more northern and western habitats in the U.S. and Canada had seasonal peaks in forb use during spring and/or summer, and browse or grass replaced forbs as the primary food item during the rest of the year (Mason 1952, Dirschl 1963, Hlavachick 1968, Severson et al. 1968, Beale and Smith 1970, Mitchell and Smoliak 1971, Schwartz and Nagy 1976). Where only fall (Couey 1946), winter (Bayless 1969), or summer (Smith and Malechek 1974) diets were reported, forbs also played secondary role, relative to browse, in pronghorn diets. Our data, supported by data of Buechner (1950) and Beasom et al. (1982), suggest pronghorns primarily are forb eaters in the southeastern part of their distribution.

Half-shrub sundrop *(Calylophus serrulatus)* was the primary browse in pronghorn diets in every season but winter and averaged over 15% of the annual diet (Table 1). More than any other individual species, half-shrub sundrop contributed the most crude protein and phosphorus to spring and summer diets and the most digestible energy to diets in every season of the year.

Throughout pronghorn range *Artemisia* has been listed as an important browse (Couey 1946, Mason 1952, Dirschl 1963, Hlavachick 1968, Bayless 1969, Beale and Smith 1970, Mitchell and Smoliak 1971, Barrett 1974, Smith and Malechek 1974) or forb (Hlavachick 1968, Bayless 1969, Mitchell and Smoliak 1971, Schwartz and Nagy 1976) in pronghorn diets. The genus *Artemisia* also contributed significantly to the diet of pronghorn in this study. Sand sagebrush *(A. filifolia)* was second-most-important browse, comprising 13% of the annual diet and 20% of the winter diet of pronghorn. Whitesage *(A. ludoviciana)* was the second or third ranking forb in every season and averaged 8% in the annual diet (Table 1). Even though these *Artemisia* species were of dietary importance, their contribution to nutrient supply was moderate except during winter and spring. Thus, importance of a plant may be relative in nature depending upon their nutrient content. Furthermore, while Mitchell and Smoliak (1971) suggested managers of pronghorn habitat must consider the importance of *Artemisia*, data from the Trans-Pecos of Texas (Buechner 1950) and eastern New Mexico (Beasom et al. 1982) suggest pronghorn exist in habitats entirely void of *Artemisia*; thus its consideration as a mandatory component of the habitat is questionable. Oh et al. (1968) found volatile oils of *A. douglasiana* and *A. tridentata* had antibacterial properties; Nagy and Tengerdy (1968) believed that not over 50% of *A. tridendata* or *A. nova* would be tolerable in deer diets. Wallmo et al. (1977) used 20% dietary sagebrush in their mule deer model. Future research should focus on the optimal percent of *Artemisia* stands required by pronghorn, based on the nutrients, forage, and/or thermal cover it provides.

Scarlet globemallow *(Sphaeralcea coccinea)* was the dominant forb selected by pronghorn in every season but winter (Table 1) and averaged 11% of the annual diet. The genus *Sphaeralcea* was an important food item in other pronghorn habitats. Globemallow was the number 1 ranking forb in annual diets of pronghorn in eastern Colorado (Schwartz and Nagy 1976) and eastern New Mexico (Beasom et al. 1982), the number 1 ranking summer forb in Utah (Beale and Smith 1970, Smith and Malechek 1974) the third ranking forb annually in Utah (Beale and Smith 1970), the fifth ranking annual forb in Kansas (Hlavachick 1968), and was present in Alberta pronghorn diets (Mitchell and Smoliak 1971).

Other important forbs were bladderpods (*Lesquerella* sp.) in winter and spring, Texas croton *(Croton texensis)* in fall, and bractless mentzelia *(Mentzelia nuda)* in winter (Table 1). As an example of the seasonal importance, Texas croton contributed more crude protein and more phosphorus to autumn pronghorn diets than any other species.

Nutrient Composition

Crude Protein

Seasonal crude protein estimates ranged from a low of 9.8% in winter pronghorn diets to a high of almost 11.4% in spring; summer and fall estimates were intermediate (Table 2). Smith and Malechek (1974) reported considerably higher spring and summer crude protein levels in pronghorn diets in Utah. Compared with crude protein estimates for pronghorn diets in Colorado (Schwartz et al. 1977), our spring, summer, fall, and winter estimates were similar, respectively, to their March, August, October, and January estimates that varied from 7.3 to 10.4%. Spring crude protein was lower in diets estimated in our study than for Colorado pronghorns during April and May.

Maintenance requirements for protein have been compared to the 6–8% required by deer (*Odocoileus* sp.) (Schwartz et al. 1977). Crude protein in the forage selected by pronghorn in our study was adequate for maintenance, similar to the findings of Schwartz et al. (1977).

Phosphorus

Estimates of phosphorus in the diets of pronghorn were highest in spring (0.18%), lowest in winter (0.15%), and intermediate in summer and fall (0.16 and 0.17%, respectively) (Table 2). The high value in spring was because half-shrub sundrop and sand sagebrush were relatively high in phosphorus content during that season and they comprised 33% of the diet. We found high levels of phosphorus in pronghorn diets during rapid plant growth in spring, as predicted by Smith and Malechek (1974), but Schwartz et al. (1977) did not.

Estimates of phosphorus for pronghorn diets in this study were lower than those reported for Utah pronghorns (Smith and Malechek 1974), except in late summer. Our results were, however, comparable to results from Colorado under "heavy" cattle grazing (Schwartz et al. 1977) except during the third period of April–July. If pronghorn, like sheep, require 0.20 to 0.28% phosphorus as indicated by Schwartz et al. (1977), then pronghorn range on our study area was

Table 2. Estimated nutrient content of pronghorn diets in the Texas Panhandle.

Constituent	Season of Year				
	Spring (91.9)[1]	Summer (87.8)	Fall (81.1)	Winter (70.5)	Annual (82.8)
Crude Protein (%)	11.4	10.5	10.1	9.8	10.4
Phosphorus (%)	0.18	0.16	0.17	0.15	0.17
IVOMD[2]	6.90	67.0	53.0	61.0	63.0
Digestible energy (Kcal/Kg)	2,656.0	2,631.0	2,227.0	2,424.0	2,482.0

[1]Percent of diet tested
[2]In vitro organic matter digestibility.

deficient in phosphorus, as are most western ranges.

Digestible Energy

Digestible energy in pronghorn diets was lowest in the fall, approaching 2,227 kcal/kg (Table 2). Highest estimates of digestible energy were found in spring and summer and were very similar to each other (2,656 and 2,631 kcal/kg, respectively), while winter estimates were intermediate (2,424 kcal/kg) (Table 2). During rapid plant growth, higher digestibilities are expected, and usually more energy would be available to pronghorns (Smith and Malechek 1974, Schwartz et al. 1977). If pronghorns are comparable to deer, low energy levels in autumn could affect ovulation in young females (Abler et al. 1976).

Average IVOMD digestion coefficients for spring, summer, fall, and winter were 69%, 67%, 53%, and 61%, respectively. Digestion coefficients reported for 2 Utah study areas (Smith and Malechek 1974) averaged across spring and summer were 68% and 70%, very similar to our results. Our spring and fall values for digestion coefficients of pronghorn diets were the same as reported from Colorado (Schwartz et al. 1977), but our summer and winter values were much higher (Table 2).

Conclusion

Pronghorns primarily eat forbs in the panhandle of Texas just as they do in eastern New Mexico (Beasom et al. 1982) and the Trans-Pecos of Texas (Buechner 1950). Browse is of secondary importance. Pronghorn seem to have a dietary affinity for either *Sphaeralcea* or *Artemisia,* or both regardless of the habitat in which the animals reside. But whether these are mandatory habitat components is questionable.

Potential bias in the technique used includes (1) the masking of the important relationship between pronghorn selection, plant phenology and nutrient content, (2) the inability to account, nutritionally, for an average of 17% of a pronghorn's diet if plants known to be eaten were difficult to find, and (3) the inability to adjust estimates of nutrient content based on weight of forage consumed. Bias (1) could be improved by more intensive and frequent sampling. Although bias (2) might be improved through more intensive sampling, Schwartz et al. (1977) lacked an average of 18% of the diet even though they used tame pronghorn for estimating botanical composition and hand-plucked plant samples for subsequent nutrient analyses. Bias (3) may be the most difficult to overcome.

Yet, combination of fecal analysis for botanical composition and nutrient content from samples of plants known to be ingested provided a fair estimate of nutrient content of the diet. The estimates indicated pronghorns received at least an adequate supply of nutrients from the range throughout the year to support maintenance, if their requirements are similar to sheep. However, it is difficult to evaluate whether nutrition is adequate to support optimum reproduction. H.G. Kothmann (personal communication) believes that the fawn:doe ratio of 0.7–0.8 is necessary for population growth with ample hunter harvest, while 0.4–0.5 was the ratio he considers will allow annual replacement for maintaining the panhandle population under the current harvest levels. For the period 1979–80, the 3-year Oldham County average fawn:doe ratio was 0.21 (Kothmann, personal communication) and was considered poor production. The Texas panhandle regional average for 1979–81 was similar at a 0.18 ratio of fawns per doe (Kothmann 1982).

Critical periods of nutritional stress for pronghorn would be late gestation, early lactation, and prior to ovulation for the doe; and at lactation and weaning for the fawn. Nutrient content of pronghorn diets in our study was similar to diets from Utah (Smith and Malechek 1974) and Colorado (Schwartz et al. 1977) except for our lower spring and fall values for protein and digestibility. Since pronghorn have higher requirements for reproduction during spring and fall, inadequate nutrition could be at least one of the factors that operated to depress pronghorn reproduction in the Texas Panhandle during 1979–81.

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