Horses and Cattle Grazing in the Wyoming Red Desert, II. Dietary Quality

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Abstract

Botanical composition of horse and cattle diets from fecal analysis and nutrient quality of hand-harvested forages used by these herbivores were evaluated to assess dietary quality during the summer and winter seasons of 1981 in the Wyoming Red Desert. Dietary crude protein estimates averaged 7.5±0.1% and 9.0±0.5% during the summer for horses and cattle, respectively. Dietary crude protein estimates in the winter were lower, averaging 6.1±0% and 6.0±0% for horses and cattle, respectively. Estimated dietary calcium levels for both herbivores were high through the summer and winter, while dietary phosphorus levels appear to be deficient during both seasons. Average in vitro dry matter disappearance coefficients for horses and cattle during the summer were 52±2% and 52±2%, respectively. During the winter these values dropped to 39±1% and 40±1% for horses and cattle, respectively.

Estimates of the nutrient content of diets selected by animals from a vegetation complex are useful for evaluating the nutrient quality of a habitat for ungulates. For free-ranging ungulates like feral horses *(Equus caballus)* and cattle *(Bos taurus)*, gross estimates must sometimes be substituted for more refined techniques when the latter are limited. Information of the latter type is not available for this region for these 2 species. The objective of this study was to evaluate nutrient content of diets for horses and cattle grazing together under a heavy and a moderate stocking level using botanical composition of diets determined by fecal analyses, and nutrient composition of herbages determined from hand-harvested samples.

Study Area and Methods

The study was conducted in the Red Desert of Wyoming approximately 93km northeast of Rock Springs, Wyo., in Sweetwater County. A semi-arid climatic pattern prevails over the area. Three distinct vegetation types—sagebrush-grass, saltbush, and greasewood-rabbitbrush—cover most of the area. For a more complete description of the study area see Krysl et al. (1984).

Grazing treatments used were: moderate grazing intensity of horses and cattle in combination (MHC) and heavy grazing intensity of both species in combination (HHC). Summer grazing period was from June 7 to August 7, 1981, while winter grazing period was from November 7 to December 21, 1981. Detailed information on grazing treatments is found in Krysl et al. (1984).

Composite samples of 29 ungrazed forage species were obtained at approximately 14-day intervals through the summer study period by hand-harvesting 20 or more plants of each species from the general area. Only 12 forage species were collected during the winter period due to decreased availability. Specific plant parts were selected to simulate those observed being consumed by horses and cattle. Although studies indicate hand-picked samples sometimes differ in nutrient content from samples collected with an esophageally fistulated animal (Edlefsen et al. 1960, Campbell et al. 1968) the magnitude of the difference is not great enough to eliminate the method for use in range nutrition studies.

Samples were weighed and frozen at approximately −5°C in a conventional freezer in the field. They were later dried in a forced-air oven at 45°C for 48 hours, reweighed for dry matter determination, ground in a Wiley mill to pass a 40-mesh screen, and stored in air-tight containers for chemical analysis.

Forages were analyzed for percentage nitrogen by the Kjeldahl procedure [Association of Official Agricultural Chemists (AOAC) 1970] and converted to percentage crude protein using (%N × 6.25). In vitro dry matter disappearance (IVDMD) was determined by an acid-pepsin modification (Vavra et al. 1973) of the method described by Tilley and Terry (1963). Calcium and phosphorus concentrations were determined for hand-harvested samples as described by AOAC (1970).

Since nutrient intake could not be measured directly, a weighted nutrient consumption estimate was obtained for each collection period on both study areas in a manner similar to Urness and McCulloch (1973). Estimates of dietary crude protein, IVDMD, calcium, and phosphorus for horses and cattle were determined by multiplying the nutrient content of each collected plant species by that species percentage relative frequency in the diet (Krysl et al. 1984). These weighted values were then summed across all plant species within each season and divided by the percentage of the diet tested to estimate the nutrient content of the diet.

Results and Discussion

Summer

Indian ricegrass *(Oryzopsis hymenoides)*, prairie Junegrass *(Koeleria cristata)*, thickspike wheatgrass *(Agropyron dasystachyum)*, needleleaf sedge *(Carex eleocharis)*, Sandberg bluegrass *(Poa sandbergii)*, bottlebrush squirreltail *(Sitanion hystrix)*, and needleandthread *(Stipa comata)* were the major grasses and sedges consumed by horses and cattle. Important shrubs utilized by horses and cattle were winterfat *(Ceratoides lanata)*, fourwing saltbush *(Atriplex canescens)*, spiny hopsage *(Grayia spinosa)*, and nuttall saltbush *(Atriplex nuttalli)* (Krysl et al. 1984).

Grasses and sedges exhibited the lowest crude protein levels followed by forbs and shrubs during the summer (Table 1). Troelsen (1969) has reported forbs are generally more nutritious than grasses with grasses generally showing sharp declines in nutrients with advancing season.

Dietary crude protein estimates for cattle in the HHC pasture averaged 8.5% and ranged from 9.9% in early summer to 6.8% by summers end, while estimates for the MHC pasture were slightly higher (9.5%) for the same time period, ranging from 10.7 to 8.2%, (Table 2). The slight difference between pastures was the result of cattle in the MHC pasture utilizing substantially more shrubs (36% vs 28%) and forbs (16% vs 9%) than cattle in the HHC pasture (Krysl et al. 1984). Shrubs during this time generally contained higher crude protein levels than grasses and sedges (Table 1).

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Table 1. Percent crude protein (CP), calcium (Ca), phosphorus (P), and in vitro dry matter disappearance (IVDMD) ± standard deviation for major summer forages in 1981 on the study area.

Forage	CP	Ca	P	IVDMD
Grasses and Sedges:				
Sandberg bluegrass	4.5 ± 0.9[a]	0.39 ± 0.10	0.09 ± 0.02	49 ± 7
Needleand thread	7.1 ± 1.3	0.38 ± 0.08	0.08 ± 0.01	52 ± 6
Indian ricegrass	6.7 ± 2.0	0.42 ± 0.02	0.13 ± 0.06	53 ± 5
Needleleaf sedge	7.3 ± 0.5	0.09 ± 0.05	0.10 ± 0.02	54 ± 3
Bottlebrush squirreltail	7.9 ± 1.8	0.48 ± 0.09	0.17 ± 0.04	52 ± 5
Thickspike wheatgrass	7.1 ± 1.4	0.54 ± 0.07	0.13 ± 0.05	56 ± 7
Shrubs:				
Rubber rabbitbrush[b]	9.7 ± 1.3	0.65 ± 0.07	0.18 ± 0.02	45 ± 3
Gray horsebrush	8.0 ± 0.4	0.77 ± 0.12	0.15 ± 0.05	48 ± 2
Big sagebrush	10.4 ± 1.4	0.60 ± 0.06	0.26 ± 0.02	53 ± 2
Nuttail saltbush	7.9 ± 1.3	1.10 ± 0.07	0.12 ± 0.03	51 ± 4
Winterfat	11.8 ± 0.3	1.24 ± 0.05	0.13 ± 0.01	56 ± 4
Douglas rabbitbrush	10.3 ± 2.1	1.23 ± 0.07	0.14 ± 0.03	50 ± 3
Greasewood	15.6 ± 1.6	0.60 ± 0.09	0.18 ± 0.03	68 ± 5
Fourwing saltbush	12.9 ± 2.1	1.01 ± 0.09	0.19 ± 0.02	61 ± 6
Spiny hopsage	11.8 ± 3.4	0.97 ± 0.28	0.12 ± 0.03	61 ± 6
Forbs:				
Scurfpea	13.7 ± 1.7	2.83 ± 1.10	0.14 ± 0.04	54 ± 7
Locoweed	16.8 ± 2.1	1.39 ± 0.83	0.13 ± 0.03	72 ± 5
Cryptantha	6.4 ± 1.0	3.05 ± 1.80	0.10 ± 0.02	63 ± 5
Greenmolly summercypress	10.3 ± 1.0	0.65 ± 0.09	0.14 ± 0.01	61 ± 3
Low penstemon	5.9 ± 1.1	1.23 ± 0.17	0.15 ± 0.05	50 ± 5
Evening primrose	6.7 ± 0.7	1.86 ± 0.13	0.17 ± 0.03	47 ± 7

[a]Variation among dates of sampling (N = 4).
[b]Scientific names for species not mentioned in text are: rubber rabbitbrush *(Chrysothamnus nauseosus)*, big sagebrush *(Artemisia tridentata)*, Douglas rabbitbrush *(C. viscidiflorus)*, greasewood *(Sarcobatus vermiculatus)*, scurfpea *(Psoralea tenuiflora)*, locoweed (*Astragulas* spp.), cryptantha (*Cryptantha* sp.), greenmolly summercypress *(Kochia americana)*, low penstemon *(Penstemon humilis)*, and evening primrose (*Oenothera* sp.).

Dietz (1965) reported ruminants usually require 12% crude protein in the diet for adequate growth and reasonable reproduction, although 6 to 8% is adequate for maintenance and support of rumen functions. The National Research Council (NRC) (1976) guidelines on nutrient requirements show mature pregnant cows (350–650kg) require a minimum of 6% crude protein. Following parturition, requirements increase to between 9 and 11% crude protein depending on level of milk production. Bulls require 8 to 10% crude protein for proper maintenance and growth. For moderate weight gains (0.3–0.7 kg/day) steers and heifers need between 8 and 11% crude protein. Diets consumed by cattle during the summer on the Red Desert appear to contain an adequate level of crude protein for maintenance, growth, reproduction, and lactation.

Dietary crude protein estimates for horses in the HHC and MHC pastures varied only slightly through the summer averaging about 7.5% (Table 2). Horses on both pastures utilized approximately the same forages, so little difference in dietary crude protein was noted between stocking densities.

According to NRC (1978), mature horses performing light to medium work require a diet containing 10% crude protein. Protein requirements increase to 12 and 14% during the last third of gestation and peak lactation, respectively. Growing foals require 19% crude protein for optimal growth. Dietary protein of horses during the summer appears to be below recommended maintenance levels. Estimates of the protein contents of the diets in this study may be lower than amounts actually consumed due to horses selecting plants or plant parts higher in nutrient content than those simulated by hand-picked forages (Kiesling et al. 1969, Schwartz et al. 1977).

Percentage IVDMD declined through the summer for all forage classes. Forbs were generally more digestible (72 to 47%) than shrubs (68 to 45%) or grasses and sedges (56 to 49%) (Table 1). Studies by Cook and Harris (1968) and Lewis et al. (1975) also showed that forbs were generally highest in digestion coefficients followed by shrubs and grasses.

Dietary IVDMD estimates for cattle averaged 51% (56 to 48%) in the HHC pasture and 53% (55 to 51%) in the MHC pasture

Table 2. Estimated nutrient intake of horses and cattle during summer under heavy (HHC) and moderate (MHC) stocking intensities.

	Treatment			
	HHC		MHC	
Nutrient	Horses (95.0)[a]	Cattle (95.0)	Horses[b] (95.3)	Cattle (92.1)
Crude protein (%)	7.5 ± 0.50	8.5 ± 1.20	7.5 ± 0.70	9.5 ± 0.90
Calcium (%)	0.63 ± 0.09	0.82 ± 0.10	0.68 ± 0.10	0.89 ± 0.15
Phosphorus (%)	0.13 ± 0.03	0.13 ± 0.03	0.10 ± 0.01	0.13 ± 0.03
Ca:P ratio	5.2 ± 1.6	6.7 ± 1.1	6.6 ± 0.7	7.1 ± 1.1
IVDMD[c] (%)	53 ± 4	51 ± 3	50 ± 1	53 ± 1

[a]Percent of diet tested.
[b]Variation among dates of sampling N = 3, whereas all others N = 4.
[c]In vitro dry matter disappearance.

Table 3. Percent crude protein (CP), calcium (Ca), phosphorus (P), and in vitro dry matter disappearance (IVDMD) ± standard deviation for major winter forages in 1981 on the study area.

Forage	CP	Ca	P	IVDMD
Grasses:				
Thickspike wheatgrass	3.9 ± 0.7[a]	0.52 ± 0.11	0.06 ± 0.01	39 ± 5
Bottlebrush squirreltail	5.5 ± 0.6	0.39 ± 0.10	0.09 ± 0.01	46 ± 1
Indian ricegrass	4.0 ± 0.2	0.33 ± 0.09	0.06 ± 0.02	42 ± 4
Sandberg bluegrass	3.7 ± 0.4	0.42 ± 0.05	0.06 ± 0.01	40 ± 1
Needleandthread	5.6 ± 1.2	0.31 ± 0.01	0.07 ± 0.02	43 ± 3
Shrubs:				
Big sagebrush	9.1 ± 0.7	0.46 ± 0.02	0.15 ± 0.02	47 ± 5
Gray horsebrush	6.1 ± 0.2	0.88 ± 0.22	0.11 ± 0.02	31 ± 1
Rubber rabbitbrush	6.8 ± 0.4	0.49 ± 0.05	0.09 ± 0.01	45 ± 1
Fourwing saltbush	7.3 ± 1.8	0.97 ± 0.12	0.09 ± 0.02	42 ± 2
Douglas rabbitbrush	6.7 ± 0.4	1.60 ± 0.31	0.10 ± 0.01	42 ± 2
Winterfat	8.1 ± 0.9	1.50 ± 0.12	0.10 ± 0.01	42 ± 2

[a]Variation among dates of sampling (N = 4).

(Table 2). Urness and McCulloch (1973) have developed general categories for rating IVDMD values. These categories are excellent (>50), good (40–50), fair (30–40), and poor (<30). It appears that diets consumed by cattle during the summer were providing fair to excellent energy levels.

Dietary IVDMD estimates for horses averaged 53% (59 to 48%) in the HHC pasture while estimates for the MHC pasture averaged 50% (51 to 49%) (Table 2). Using Urness and McCulloch (1973) categories, it appears that diets were providing fair to excellent energy through the summer.

Calcium content of plant species varied greatly through the summer, as well as between forages classes (Table 1). A general upward trend in calcium levels was noted for grasses and forbs. Charley (1977) has reported that calcium is not as mobile as other minerals and therefore it becomes relatively more concentrated than other minerals as plants mature.

Dietary calcium estimates for cattle averaged 0.82% (0.70 to 0.95%) for the HHC pasture with no consistent change through the summer (Table 1). Estimates in the MHC pasture were slightly higher average 0.89% (0.78 to 1.13%) (Table 1).

Mature pregnant cows require 0.18% calcium in the diet, but this increases to 0.28–0.39% following parturition, as a result of increased nutrient demands of lactation (NRC 1976). Bulls have the same calcium requirement as mature cows (0.18%). Calcium levels of 0.18 to 0.32% are needed by steers and heifers to achieve moderate weight gains. In view of these recommendations, more than adequate levels of calcium are being provided by the diet. Calcium levels are generally adequate on most western rangelands (Short 1981). However, problems related to high calcium levels in combination with low phosphorus levels will be discussed in a later section.

Dietary calcium estimates for horses averaged 0.63% (0.56 to 0.77%) in the HHC pasture with an average of 0.68% (0.67 to 0.70%) occurring in the MHC pasture (Tables 1). Recommended levels of calcium in horse diets varies from 0.20 to 1.0% depending on age and physiological status of the animal (NRC 1978). Calcium levels reported in this study appear to be adequate for growth and maintenance.

Phosphorus content generally declined in all forage classes with advancing season. Grasses and sedges contained the lowest phosphorus levels of all forage classes (Table 1). Cook and Harris (1968) found similar results for forages on Utah summer ranges.

Dietary phosphorus estimates for cattle averaged 0.13% (0.18 to 0.10%) for both HHC and MHC pastures (Table 1). NRC (1976) reported that mature pregnant cows require 0.18% phosphorus with demands increasing to 0.25–0.39% following parturition. Varnell et al. (1979) stated that cattle require between 0.19 to 0.50% phosphorus in their rations. Our results indicate that phosphorus is deficient during most of the summer. Possible alternative sources of phosphorus includes utilization of bones when available and coprophagy (eating of feces) which was commonly observed in the study pastures. However, we did not note any visual gross abnormalities related to phosphorus in the unsupplemented study animals. In most instances cattle were utilizing horse feces. During times of stress, animals have been known to practice coprophagy in order to utilize nutrients that have passed through the digestive tract and have become more concentrated than in the available forages (Evans 1977, Schurg et al. 1977).

Dietary phosphorus levels in horses averaged 0.13% (0.09 o 0.18%) in the HHC and 0.10 (0.10 to 0.12%) in the MHC (Table 1). NRC (1978) suggests that phosphorus levels for horses should be approximately 0.14 to 0.63% depending on type and status of animal. Our results indicate that phosphorus was deficient during most of the summer. Horses, like cattle, may have been supple-

Table 4. Estimated nutrient intake of horses and cattle during winter under heavy (HHC) and moderate (MHC) stocking intensities.

	Treatment			
	HHC		MHC	
Nutrient	Horses (99.1)[a]	Cattle (99.4)	Horses (99.0)	Cattle (99.7)
Crude protein (%)	6.1 ± 0.20[b]	6.0 ± 0.50	6.1 ± 0.20	6.0 ± 0.50
Calcium (%)	0.68 ± 0.10	0.66 ± 0.09	0.70 ± 0.05	0.64 ± 0.11
Phosphorus (%)	0.08 ± 0.01	0.08 ± 0.01	0.09 ± 0.01	0.08 ± 0.01
Ca:P ratio	7.4 ± 1.0	7.9 ± 0.4	8.1 ± 0.4	7.7 ± 1.0
IVDMD[c] (%)	40 ± 1	40 ± 1	39 ± 1	40 ± 1

[a]Percent of diet tested.
[b]Variation among dates of sampling (N = 4).
[c]In vitro dry matter disappearance.

menting their phosphorus needs by utilizing bones available in the pastures and by practicing coprophagy. Evans (1977) and Schurg et al. (1977) reported horses under stress would utilize feces to obtain necessary nutrients.

A better measure of calcium and phosphorus requirements is the dietary calcium to phosphorus ratio (Ca:P)(Murray et al. 1978). In the HHC pasture, cattle Ca:P ratios averaged 6.7:1 (4.8:1 to 7.6:1), whereas those in the MHC pasture averaged 7.1:1 (4.3:1 to 10.3:1) (Table 1). In the MHC pasture Ca:P ratios in horse diets averaged 5.2:1 (3.1:1 to 7.0:1), while the MHC pasture dietary levels averaged 6.6:1 (4.3 to 7.4:1) (Tables 1).

Ca:P ratios of 2:1 or 1:1 are considered optimal for animal performance (Swenson 1977). National Academy of Sciences (NAS) (1980) has reported Ca:P ratios of up to 7:1 were tolerable if phosphorus levels are high. The Ca:P ratios in the diets in this study are not within tolerable limits for cattle or horses considering the low phosphorus levels present.

Winter

Needleandthread, Sandberg bluegrass, thickspike wheatgrass, and Indian ricegrass were the major grasses consumed by horse and cattle during the winter. Shrubs accounted for approximately 35% of the diets with winterfat, gray horsebrush *(Tetradymia canescens),* and fourwing saltbush being the primary utilized species. Forb use was neglible during the winter in both pastures (Krysl et al. 1984).

Crude protein levels in the forages remained stable during the winter period with shrubs containing higher crude protein levels than grasses through the winter (Table 3).

Dietary crude protein estimates for cattle in both the MHC and HHC pastures averaged approximately 6.0% and ranged from (5.3 to 6.6%) (Tables 4). Estimates decreased as the season progressed due to increased plant maturity. Dietz (1965) and NRC (1976) have stated that a 6.0% crude protein level is adequate for rumen function in cattle.

Dietary crude protein estimates for horses were similar to those for cattle during the winter season, averaging about 6.1% and ranging from 5.9 to 6.3% (Table 4). According to NRC (1978), horses require a minimum of 10% crude protein for maintenance. It would appear, based on our findings, horses are not meeting maintenance requirements during the winter season.

Percent IVDMD of grasses averaged 42% (46 to 39%) and shrubs also averaged 42% (47 to 31%) (Table 3). Beaty and Engel (1980) reported that green leaves are more digestible than dead leaves, and leaves are higher in translocatable materials than are stems, therefore forage quality is reduced more by leaf death than stem death (Taylor and Templeton 1976).

Dietary IVDMD estimates for wintering cattle and horses averaged 40% for both HHC and MHC pastures (Table 4). Using Urness and McCulloch's (1973) general catagories, diets appear to be providing a fair level of energy during the winter.

Calcium content of forage species varied greatly throughout the winter. Shrubs generally contained higher calcium levels than grasses (Table 3).

Dietary calcium estimates for cattle averaged approximately 0.65% for both MHC and HHC pastures with estimates declining as the winter season progressed (Table 4). Since the NRC (1976) puts the calcium requirement level at 0.18% for cattle during the winter, forages in the Red Desert are providing more than adequate calcium levels.

Horses had dietary calcium estimates averaging approximately 0.70% for both MHC and HHC pastures (Table 4). As with cattle, dietary calcium levels declined with advancing season. Recommended levels of calcium in the diet varies from 0.20 to 1.0% depending on age and physiological status of the animal (NRC 1978). Dietary intake provided more than adequate levels of calcium to horses.

Phosphorus content steadily declined throughout the winter season. Grasses contained lower phosphorus levels than shrubs (Table 3).

Dietary phosphorus estimates for cattle were 0.08% for both MHC and HHC pastures (Table 4). Mature pregnant cows require 0.18% phosphorus in the diet (NRC 1976). Our data indicate dietary phosphorus is deficient throughout the winter season. During this study cattle were observed utilizing bones and old horse and cattle feces when available, which might have off-set low phosphorus levels provided by forages.

Dietary phosphorus estimates for horses in both treatments were approximately 0.09% throughout the winter season (Table 4). NRC (1978) suggests phosphorus levels should be between 0.14 and 0.63% depending on type and status of the animal. Our data indicate dietary phosphorus was deficient throughout the winter season. Horses, like cattle, may be supplementing their phosphorus needs by utilizing bones available in pastures and by the practice of coprophagy.

Dietary Ca:P ratios for horses and cattle in both HHC and MHC pasture ranged from 7.4:1 to 8.1:1 (Table 4). Generally ratios remained constant during the winter. Our findings put Ca:P ratios beyond the tolerable limits for cattle and horses reported by NAS (1980).

Conclusion

Our results suggest cattle select higher quality diets than horses during both the summer and winter on the Red Desert. Dietary crude protein estimates revealed cattle were meeting their nutritional needs whereas horses appeared to be on a sub-maintenance nutritional plane during both summer and winter seasons. IVDMD estimates showed that horses and cattle diets were providing fair to excellent energy levels during the summer and fair energy during the winter. Dietary calcium levels were more than adequate to meet nutritonal requirements of both cattle and horses during the summer and winter seasons. Dietary phosphorus levels were below minimum requirement levels throughout the year for both cattle. and horses. It is thought that cattle and horses were supplementing their phosphorus requirements by utilizing bones and practicing coprophagy. Ca:P ratios were high most of the year and during the winter they were above tolerable limits for both cattle and horses. Whether these findings directly reflect the nutritional level of free-roaming cattle and horses in the Red Desert is difficult to address. Free-roaming animals with larger, more varied habitats than those available to the pasture-confined animals in the study, would be able to select habitats with possibly different nutrient quality. Also, more years of data collection would help to document the effect climatic fluctuations are having on species composition and standing crop and hence the diet composition and quality of the animals grazing the area. Previous nutritional information for cattle and horses is non-existent for this area. The authors hope that this paper will stimulate additional research for this area.

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