Botanical and Chemical Composition of Cattle and Sheep Diets on Pinyon-Juniper Grassland Range¹

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Highlight

Diets collected by use of esophageal fistulated steers and sheep on foothill range in southcentral New Mexico where compared botanically and chemically. Sheep diets were generally higher in forbs and lower in grass than cattle diets and contained more forbs than grass except during June, July and August. Important forbs in sheep diets were caruth sagewort, vervain, and globemallow. Cattle diets contained more grass than forbs in all periods except April, with blue grama the most important grass followed by sideoats grama, wolftail, and threeawns. Sheep diets were consistently higher in crude protein and ash content than cattle diets, but there were no significant differences in cell-wall constituents and in vitro dry matter disappearance among dates or between cattle and sheep diets.

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La Composicion Botanica y Quimica de las Dietas del Ganado Bovino y Ovino en una Pradera Tipo Pinyon-Juniper

Resumen³

Se llevó a cabo el estudio en el Estado de New Mexico, E.U.A. Las dietas del ganado ovino constituyeron en mas hierbas que gramíneas con la excepción de los meses de Junio, Julio y Agosto. Las más importantes hierbas fueron *Artemisia carruthii*, *Verbena* spp. y *Sphaeralcea coccinea*. Las dietas del ganado bovino constituyeron en mas gramíneas que hierbas con la excepción del mes de Abril. La gramínea mas importante fué *Bouteloua gracilis*. *Bouteloua curtipendula*, *Lycurus phleoides* y *Aristida* spp. fueron secundarias en importancia. Las dietas del ganado bovino tuvieron mas proteína cruda. No hubo diferencia en los contenidos de fibra cruda ni de la digestibilidad entre las dietas del ganado bovino y ovino.

Common use or dual grazing by more than one class of livestock offers possibilities for increasing livestock production without increasing land areas. Such practices are becoming increasingly more important as production costs increase and opportunities for acquiring additional land decrease.

Some rangelands are better suited for grazing by one class of livestock than another, but many ranges may be better utilized by cattle and sheep grazing together (Cook, 1954; Smith, 1965; Stoddart and Smith, 1955). Rangelands with diverse topography and vegetation are more suitable for dual use by sheep and cattle than for single species use (Cook, 1954; Merrill et al., 1966; Merrill and Young, 1954;

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Stoddart and Smith, 1955). Studies in Utah and Texas have shown that stocking with two or more classes of livestock in the same pasture increased gains per head and per acre, maintained or improved range condition, increased carrying capacity, reduced supplemental feeding, resulted in more uniform use overall, and increased gross and net returns when compared to single use by sheep or cattle (Cook, 1954; Huss and Allen, 1969; Merrill and Miller, 1961; Merrill et al., 1966; Merrill and Young, 1954).

Hull et al., (1957) and Meyer et al. (1957) showed that sheep and cattle select diets which are quite different in plant parts, botanically and chemically, when animals grazed on adjacent pastures of a single species or adjacent pastures consisting of two species. Other investigators working with animals on native range reported that cattle diets consisted mainly of grasses, with forbs and browse of lesser dietary importance. While sheep readily eat grasses, they generally consume greater amounts of forbs and browse than cattle (Cook, 1954, 1956; Cook et al., 1963, Cook et al., 1967; Cook and Harris, 1950; Cook et al., 1965; Smith and Julander, 1953). For example, Cook et al. (1963) reported cattle diets contained 55% grass, 25% forbs, and 20% browse whereas the diets of sheep grazing the same areas were composed of 35% grass, 40% forbs, and 25% browse.

Several studies have shown that sheep select diets which are significantly higher in total protein and digestible protein than cattle diets, whereas cattle diets are significantly higher in cellulose. Sheep diets also contained more ether extract and lignin than cattle diets (Cook et al., 1963; Cook et al., 1967; Van Dyne and Heady, 1965b). These differences in diets may be due to the fact sheep select diets high in browse, forbs, and plant parts which are high in protein, ether extract, and lignin, but cattle consume large quantities of grass stems, which are high in cellulose (Cook et al., 1963; Van Dyne and Heady, 1965b).

The objective of this study was to compare botanical and chemical composition of diets of cattle and sheep grazing together on the same range.

Materials and Methods

The Fort Stanton Cooperative Range Research Station is located in the foothills between Sierra Blanca and the Capitan Mountains in southern Lincoln County, New Mexico. The topography is characterized by deep canyons, arroyos, and mesas with elevations varying from 6200 to 7500 feet. Fort Stanton is in a transition zone between the grama-galleta steppe and juniper-pinyon woodland vegetation types (Kuchler, 1964). The vegetation is open grassland on the mesas, canyon floors, and lowlands with woody species on the slopes (Groce and Pieper, 1967).

Table 1. Botanical composition (%) of area grazed by esophageal fistulated sheep and cattle at Fort Stanton, 1969-70.

Species ¹	Composition ²
Grasses	
Blue grama (<i>Bouteloua gracilis</i> , (H.B.K.) Lag.)	66.4
Sideoats grama (<i>B. curtipendula</i> , (Michx.) Torr.)	4.6
Hairy grama (<i>B. hirsuta</i> Lag.)	T
Threeawns (<i>Aristida</i> spp.)	0.8
Galleta (<i>Hilaria jamesii</i> (Torr.) Benth.)	1.0
Wolftail (<i>Lycurus phleoides</i> H.B.K.)	16.7
Mat muhly (<i>Muhlenbergia richardsonis</i> (Trin.) Rydb.)	3.0
Ring muhly (<i>M. torreyi</i> (Kunth.) Hitchc.)	1.2
Halls panic (<i>Panicum hallii</i> Vasey)	T
Bottlebrush squirreltail (<i>Sitanion hystrix</i> (Nutt.) J. G. Smith)	—
Forbs	
Carruth sagewort (<i>Artemisia carruthii</i> Wood)	5.5
Locoweeds (<i>Astragalus</i> spp.)	T
Broom snakeweed (<i>Gutierrezia sarothrae</i> (Pursh.) Britt. and Rusby)	T
Vervains (<i>Verbena</i> spp.)	—
Globemallow (<i>Sphaeralcea coccinea</i> (Pursh.) Rydb.)	—
Bladderpod (<i>Lesquerella gordonii</i> (Gray) Wats.)	—
Lemonweed (<i>Pectis papposa</i> Harv. and Gray)	—
Browse	
Wavyleaf oak (<i>Quercus undulata</i> Torr.)	—
One-seeded juniper (<i>Juniperus monosperma</i> (Engelm.) Sarg.)	—
Pinon pine (<i>Pinus edulis</i> Engelm.)	—
Red barberry (<i>Berberis haematocarpa</i> Wooten)	—
Fourwing saltbush (<i>Atriplex canescens</i> (Pursh.) Nutt.)	—

¹ Nomenclature follows Kearney and Peebles, 1960.

² Those species for which no percentages are listed appeared on the area but were not sampled on the transects. T < 0.1%

The major forage species is blue grama which is dominant or codominant on all sites. Other important grass species are shown in Table 1.

The average annual precipitation for 94 years of record (1856 to 1969 with some gaps) is 15.30 inches (U. S. Weather Bureau) of which about 62% falls during the growing season of June, July, August, and September (Groce and Pieper, 1967). The climate of the area is generally mild but some relatively cold winter temperatures occur. The mean annual temperature for Fort Stanton is 52 F, with a mean minimum of 36 F and a mean maximum of 65.5 F (U. S. Weather Bureau).

The study pasture was stocked two-thirds with cattle and one-third with sheep. There were 34.5 acres per animal unit yearlong. The pasture is on a mesa at an elevation of approximately 6800 feet, convenient to corrals and water.

The botanical composition of the study areas was determined in October, 1969, by the step-point method of Evans and Love (1957).

Esophageal-fistulated steers and wethers were used to obtain forage samples from the study area. The animals were placed in the pasture to be sampled one week prior to sampling for each collection date except the January, 1970 collection when the animals were put on the sampling area the first day of sampling. Samples were collected with two steers and two sheep on two consecutive days for each sampling period.

Most of the samples were taken early in the morning after the animals had fasted overnight, but some samples were taken in the afternoon after the animals had fasted for approximately three hours. Collection periods lasted from 45 minutes to one hour.

The collected samples were drained of excess saliva, place in an insulated chest containing dry ice and returned to the Animal Nutrition Laboratory at New Mexico State University, where they were stored in a freezer. Prior to analyses, the samples were thawed and the samples for each species of animal were composited for each collection day. The composited samples were thoroughly mixed and dried in a forced-air oven for 24 hours at 65 C. They were then ground through a 20-mesh screen in a Wiley mill and stored in plastic containers. The sheep samples for August and October, 1969, were combined for each collection period because the sample for each day was insufficient for a complete analysis.

Botanical analysis of each composited sample was conducted according to a procedure similar to that described by Sparks (1968) and Sparks and Malecheck (1968). Whole plant samples of each plant species growing on the study area were collected for references.

Histological characteristics such as size and shape of cells, cell inclusions, cell wall variations, variations in the various specialized epidermal cells such as cork, guard, and silica, and the size and shape of hairs, if present, were used to identify plant species (Davies, 1959; Brusven and Mulkern, 1960; Storr, 1961) in the diet.

Each sample was analyzed in duplicate for Kjeldahl nitrogen, dry matter, ash, and silica by procedures of the A.O.A.C. (1965). The fibrous portion was assayed as cell-wall constituents (CWC) according to the procedures of Van Soest and Wine (1967). Each sample except the April 3 steer sample, was assayed in triplicate for organic matter disappearance by the procedure described by Tilley and Terry (1963). Protein, cell-wall constituents, and in vitro dry matter disappearance are expressed on an organic matter basis because of possible contamination with inorganic material.

Data were analyzed by the analysis of variance procedures appropriate for each phase. Duncan's multiple range test was used to test means where

FIG. 1. Percent of grass, forbs and browse in diets of sheep and cattle collected at different times of the year.

the analysis of variance indicated significant differences among means.

Results and Discussion

Botanical Composition of the Study Area

The composition of the plant cover of the grazed area is presented in Table 1. Blue grama is the dominant species, contributing 66.4% of the basal cover, with wolftail contributing 16.7%, the second largest amount. Other grasses contributing significant amounts to the composition of the area were sideoats grama, mat muhly, ring muhly, and galleta. The most important forb was carruth sagewort, with locoweeds and broom snakeweed contributing insignificant amounts. These data do not show seasonal availability of different species but give a general indication of the species present. The other species listed in the table were present on the area but were not encountered on the sampling transects. They contributed minor amounts to the plant cover. Wavyleaf oak formed the periphery of the grazed area, with a few plants scattered throughout. Pinyon pine and juniper plants were

Table 2. Average botanical composition (% dry weight) of sheep and cattle diets at Fort Stanton, 1969-70.

Species	April		June		July		August		October		January	
	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle
Grasses												
Blue grama	15.5	21.7	9.8	35.5	34.5	35.4	27.4	50.1	20.3	28.6	22.1	34.0
Sideoats grama	1.7	2.4	2.6	7.7	4.0	7.4	2.2	10.0	3.8	5.0	4.9	5.1
Wolftail	3.4	2.3	2.5	7.3	8.2	9.6	4.5	19.2	1.3	6.6	0.7	5.9
Threeawns	5.9	5.1	6.5	8.3	8.3	4.4	16.9	0.0	1.9	15.9	3.5	16.5
Halls panic	3.2	1.3	0.5	1.1	3.0	5.7	4.5	4.4	1.9	2.4	0.0	0.2
Bottlebrush												
Squirreltail	0.4	0.0	0.3	1.5	0.0	1.1	0.0	5.2	1.2	0.3	0.0	0.2
Sand dropseed	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ring muhly	0.0	0.3	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.2
Total	32.5	33.1	22.2	61.4	58.0	64.9	55.5	88.9	30.4	58.8	31.2	62.1
Forbs												
Carruth sagewort	42.3	42.0	31.2	10.9	10.3	0.0	8.7	1.1	25.6	14.1	18.5	9.4
Globemallow	3.6	0.5	16.0	14.2	7.7	29.3	2.8	2.2	16.1	3.8	3.5	0.2
Vervains	8.8	2.0	20.8	4.2	19.1	0.0	13.3	0.0	16.9	8.7	23.1	4.9
Locoweeds	4.6	0.3	8.3	0.4	0.0	1.4	15.4	0.0	7.2	1.9	21.2	14.0
Broom snakeweed	1.7	1.4	1.2	4.2	3.4	0.2	2.2	5.6	1.9	7.3	0.7	3.2
Bladderpod	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Lemonweed	0.0	0.8	0.0	1.4	0.6	0.4	1.6	0.0	0.0	0.9	2.0	0.2
Total	61.0	47.0	77.8	35.3	41.1	31.3	44.0	8.9	67.7	36.7	69.0	32.1
Browse												
Wavyleaf oak	5.0	19.0	0.0	1.7	0.0	3.7	0.0	2.2	1.9	4.0	0.0	0.7
Fourwing saltbush	0.0	0.6	0.0	1.0	0.6	0.0	0.0	0.0	0.0	0.3	0.0	0.5
Red barberry	0.9	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.3	0.0	1.5
Total	5.9	19.6	0.0	2.7	0.6	3.7	0.5	2.2	1.9	4.6	0.0	2.7

few and scattered, and red barberry grew under the pinyon. There were approximately five or six fourwing saltbush plants on the area.

Botanical Composition of the Diets

The analysis of variance showed a significant difference ($P < .01$) in the amount of grass and forbs in the diets between species but no differences in browse. Cattle diets were consistently higher in grasses than sheep diets except in April, while sheep diets were consistently higher in forbs than cattle diets (Fig. 1). Grasses have been reported to be the most important component of cattle diets by several workers (Galt et al., 1969; Cook et al., 1963; Van Dyne and Heady, 1965a). In general for both cattle and sheep, forbs were most important during the fall and spring and grasses during the summer. During the spring of 1969, soil moisture conditions were good and there was good growth of many forbs while the grass was still dormant.

Browse contributed small amounts to the diets of sheep and cattle except for cattle in April when wavyleaf oak comprised 19% of the diet. This was because the cattle grazed into the oak at the edge of the grazed area when the oak had begun new growth.

Cattle selected significantly more blue grama

than did sheep for all collection periods except in July, when the sheep diets contained as much blue grama as the cattle diets (Table 2). Cattle consistently selected a higher proportion of sideoats grama than did sheep throughout the year and the analysis of variance showed that the difference between cattle and sheep diets was significant at the .06 level. Except in August, wolftail was present in lower percentages in both cattle and sheep diets than in the vegetative composition of the area. The analysis of variance showed no significant difference in wolftail content of the diets among dates or between sheep and cattle. The content of threeawn in the diets was variable with sheep selecting larger amounts in April, July, and August and cattle selecting larger amounts in June, October, and January. These inconsistencies may account for the nonsignificant difference between threeawn content of cattle and sheep diets for the whole year. Threeawn comprised less than 1% of the vegetative cover of the area (Table 1), but the animals seemed to select it because threeawn appeared in amounts greater than 1% in all diet samples except one.

Halls panic was the most important of the other grasses. Sheep and cattle diets contained equal proportions of Halls panic in August while sheep

diets were higher than cattle diets in April and cattle diets higher than sheep diets in the other four collection periods. Bottlebrush squirreltail contributed minor amounts to the diets of sheep and cattle except in cattle diets in August when it contributed 5.2%. Ring muhly was found in cattle diets in minor amounts in April, July, and January.

The most important forb in the sheep and cattle diets was carruth sagewort. Sheep consistently selected higher proportions of carruth sagewort than did cattle throughout the year. The analysis of variance showed that the difference between carruth sagewort in cattle and sheep diets was significant at the .06 level. In April, sheep and cattle selected significantly higher amounts of carruth sagewort, 42.3% and 42.0% respectively, than at any other collection period. The analysis of variance showed a highly significant difference ($P < .01$) among collection dates in carruth sagewort content of the diets. It was much more important in fall, winter, and spring samples than in summer samples and most important in spring samples. Except in the July and August samples, it formed a higher percentage of the diets than of the plant cover of the area.

The amount of globemallow in the diets was nonsignificant among dates and between sheep and cattle diets, possibly because of the inconsistencies in the amount taken. The amount selected varied widely among dates and between sheep and cattle.

Sheep consistently selected larger percentages of vervain than cattle in all collection periods. Vervain contributed 23.1% to the sheep diet in January, when it was one of the three noticeably green forbs on the grazed area, along with locoweeds and carruth sagewort. Vervain contributed relatively large amounts to the forb component of sheep diets in all periods except April when it comprised 8.8% of the diet.

Locoweeds were the most important of the other forbs for sheep, which selected larger proportions than did cattle in all periods except July. Locoweeds contributed 14.0% to the cattle diets in January when they were green. For cattle, broom snakeweed was the most important of the other forbs. Cattle ate more broom snakeweed than did sheep in all collection periods except April and July. Bladderpod was found in one sample for sheep in June and one sample for cattle in January. Lemonweed contributed variable and small amounts to the sheep and cattle diets throughout the year.

Chemical Composition of the Diets

Sheep diets were significantly higher ($P < .05$) in ash content than cattle diets. This agrees with data presented by other researchers (Cook et al., 1963; Van Dyne and Hedy, 1965b). Figure 2 shows that sheep diets were consistently higher in ash content

FIG. 2. Ash, cell-wall constituent, protein content and dry matter disappearance of cattle and sheep diets on Ft. Stanton, 1969-70.

than cattle diets throughout the year. Even considering the ash contamination of the esophageal-fistula-collected samples, these values appear to be high, especially for sheep, when compared to data on the ash content of some hand-clipped Fort Stanton grass (Hatch, 1968; Boggino, 1970). Sheep are able to graze close to ground level and may pick up soil particles. The high ash value of 20.1% in the July sheep diet sample was possibly due to soil contamination or to high variability in the ash contents of the plants.

The ash content of the cattle diets decreased from April through the growing season to a low point in August and then increased rapidly with the onset of dormancy in October.

The analysis of variance indicated a highly significant difference ($P < .01$) in crude protein content of the diets among dates and between species. Sheep diets were higher in crude protein content than cattle diets for all periods (Fig. 2). Other workers have found sheep diets to be consistently higher in crude protein than cattle diets (Cook et al., 1963; Cook et al., 1967; Van Dyne and Hedy, 1965b). This was probably due to the higher percentage of forbs in sheep diets (Table 2), because the parts of forbs consumed by cattle are usually higher than grasses in crude protein (Nelson, et al., 1970). The protein content of both sheep and

cattle diets was lowest in April when the vegetation was dormant and increased rapidly when the growing season began. The sheep diets contained the largest percentage of crude protein in June when the forb content of the diet was highest and decreased slightly through July. Protein content of the cattle diets reached a peak in July when nearly all vegetation was green. Both sheep and cattle diets decreased in crude protein content after July with increasing maturity of the vegetation. Based on the National Research Council (NRC, 1970) nutrient requirement levels, the crude protein content of the diets was sufficient to maintain sheep and cattle through the gestation and lactation periods under normal ranching conditions. These requirement levels assume that total intake of dry matter sufficient.

The fibrous portion of the diets was assayed as cell-wall constituents because this analysis is reportedly more indicative of the indigestible portion of the diet than the A.O.A.C. crude fiber analysis (Van Soest and Wine, 1967). The cell-wall constituents (CWC) content of the sheep and cattle diets was highly variable with no significant differences among dates and between species. Figure 2 shows that the CWC content of the sheep diets varied widely from one collection period to another while the content in cattle diets remained relatively stable for all periods except the November collection when it was low.

The organic matter disappearance (in vitro) of the diets is presented in Figure 2. The variability was considerable and the analysis of variance indicated no significant differences among dates or between animal species.

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