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Animal age and sex effects on diets of grazing cattle

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Abstract

The effects of animal age and sex on chemical and botanical composition of diets of cattle grazing native rangelands were evaluated in a 2-year study. Samples were collected monthly from June through October using esophageally cannulated suckling calves, yearling heifers, mature cows, and mature steers. Dietary crude protein and digestibility differed among animal classes, but these differences varied over time. These 2 diet quality indicators did not vary in the same manner over time for all animal classes. Dietary crude protein varied from a low of 7.2% for steers in August 1994 to a high of 14.3% for heifers in June 1993. In vitro digestibility varied from a low of 50.7% for cows in October 1993 to a high of 74.3% for calves in June 1993. Botanical composition of diets varied with animal class and sampling date with interactions among these. Cool-season grasses accounted for an average of 70% of the diet with a range of 33 to 90%. Shrubs varied from 1 to 61% of the diet. Differences in chemical composition among age and sex classes of cattle grazing native rangeland during the growing season may be partially related to differences in botanical composition of diets. Animals used to obtain diet samples should, therefore, be of similar physiological state and age as animals being monitored for performance.

Key Words: diet selection, beef cattle, calf, steer, heifer

Resumen

En un estudio de dos años se evaluó el efecto de la edad y sexo del animal en la composición botánica y química de la dieta del ganado apacentando pastizales nativos. Las muestras se colectaron mensualmente de Junio a Octubre utilizando becerros sin destetar, vaquillas, vacas maduras y novillos con cánulas esofágicas. La proteína cruda dietaria y la digestibilidad difirieron entre las clases de animal y estas diferencias variaron a través del tiempo. Estos dos indicadores de la calidad de la dieta no cambiaron de la misma manera a través del tiempo para todas las clases de animal. La variación de la proteína cruda dietaria fue de 7.2% en la dieta de los novillos en agosto de 1994 a 14.3% en la dieta de las vaquillas en Junio de 1993. La digestibilidad in vitro vario de de 50.7% en la dieta de las vacas en Octubre de 1993 a 74.3% en la dieta de los becerros en Junio de 1993. La composición botánica de la dieta vario con la clase de animal y la fecha de muestreo con interacciones entre estos factores. Los zacates de estación fría aportaron aproximadamente el 70% de la dieta y el rango de ellos fue del 33 al 90%, los arbustos variaron del 1 al 6% de la dieta. Las diferencias en la composición química de la dieta entre edad y sexo del animal del ganado apacentando pastizales nativos durante la estación de crecimiento puede estar parcialmente relacionada a las diferencias en la composición botánica de las dietas. Los animales utilizados para obtener las muestras de las dietas deben estar en el mismo estado fisiológico y edad que los animales que están siendo monitoreados para determinar su comportamiento productivo.

Esophageal diet sampling is one technique used to obtain diet quality information needed to estimate digestibility and intake of grazing cattle. Researchers often use a single class of animals to determine diet quality for all animals. For example, some researchers have used mature steers for sampling because of their ease of handling. These steers may differ in physical stature, body composition, intake as a proportion of body weight, and nutrient requirements compared with the cattle being monitored for performance. A number of researchers have observed differences in diet selection between young, suckling ruminants and older animals (Horn et al. 1979, Ferrar Cazcarra and Petit 1995, Grings et al. 1995). Langlands (1969) found differences in diet selection due to animal age, but not sex. Mohammad et al. (1996) found limited diet compositional differences between mature cows and 2-year-old steers on semidesert range. The greatest differences occurred during fall and these authors suggested differences in diet selection between sexes may be more apparent during periods of limited forage availability. The effects of animal class (age or sex) on diet selection may be dependent on the quality as well as quantity of available herbage. Wallace et al. (1972) suggested the lack of difference between quality of available forage and selected diets of cattle on eastern Colorado rangeland during winter was due to the uniform chemical composition of forages available. The objective of this study was to evaluate the influence of animal age and sex on botanical and chemical composition of diets obtained by cattle grazing Northern Great Plains rangeland.

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Material and Methods

The study was conducted at the Fort Keogh Livestock and Range Research Laboratory near Miles City, Montana (46° 22' N 105° 5' W). Climate is continental and semi-arid with vegetation dominated by western wheatgrass [*Pascopyrum smithii* (Rydb.) Love]), threadleaf sedge [*Carex filifolia* Nutt.], needle and thread [*Stipa comata* Trin. and Rupr.], blue grama [*Bouteloua gracilis* (H.B.K.)], and downy [*Bromus tectorum* L.] and Japanese bromes [*B. japonicus* Thunb.]. Average annual rainfall in the area is 338 mm with 60% received during the 150-day, mid-April to mid-September growing season (Fig. 1)

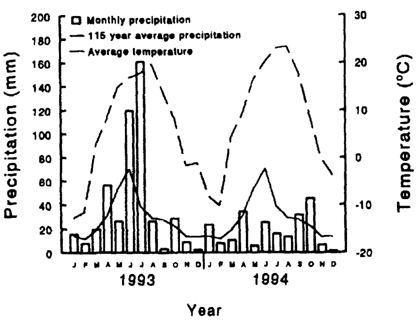

Fig. 1. Average precipitation (bars) during the study years of 1993 and 1994 compared to a 115-year average (solid line) and average monthly temperature (dashed line) during the study years.

The study utilized esophageally cannulated suckling heifer calves, yearling heifers, mature cows, and mature steers. Six mature steers (5- to 6-years old) and 6 lactating cows (2- to 5-years old) were used. All but 1 cow were used both years. Weight, body condition, and physical stature of cows was different than steers. Calves were 4 months old at the first sample collection period after having been cannulated at 2 months of age. During 1993, 6 yearling heifers and 6 heifer calves were used, while during 1994, 4 yearling heifers and 8 heifer calves were used. Yearling heifers used during 1994 were the calves used during 1993. Steers and cows had considerable experience in the pastures during earlier winters and were familiar with the vegetation and topography. Heifers had previously grazed pastures with similar range sites and were experienced with the forage species available. Calves had grazing experience but not with all forage species available.

Samples were collected each month from June through October of 1993 and 1994 in 2 vegetatively similar native rangeland pastures of 85 and 90 ha. These pastures were grazed with yearling steers at a density of 4.4 ha steer^{-1} from mid-May to mid-September 1993 and from mid-May to late August 1994.

Cattle used for diet sampling were brought to the site the day before sampling and were held overnight without feed but with water available. Collection bags were placed on cattle at 0700 hours and they were allowed to graze the first pasture for 30 to 45 min. These procedures were repeated a second day in the second pasture. Due to problems with sample collections, not all animals collected a sample for each month. Except for yearling heifers, samples from the 2 days were composited by weight, frozen, lypholyzed, and ground to pass a 1-mm mesh screen in a Wiley mill. Samples for yearling heifers for all months except October were being used to evaluate diet quality for a concurrent study that required analysis by individual pasture. Therefore, analyses were conducted on individual samples and averaged over 2 days.

Samples were divided with one-half used for analysis of crude protein (Hach 1987) and in vitro organic matter digestibility (Tilley and Terry 1963) without supplemental nitrogen and the other half used for microhistological analysis for botanical composition (Sparks and Malechek 1968). One slide of each sample was read (20 fields) for microhistological analysis at a commercial laboratory (Composition Analysis Laboratory, Fort Collins, Colo).

Forage availability on 2 representative range sites was determined during the same week that diet samples were collected. The sites were clay pan and silty-shallow and represented 15 and 49%, respectively, of the pasture area. Standing crops were visually estimated by giving a score of 1 (high) to 4 (low) in 20 randomly placed 0.25 m^2 quadrats within each of 2 range sites. Every fifth plot was clipped to ground level, dried, and weighed. Linear regression was used to estimate standing crops from vegetation abundance scores. Separate regressions were used for each range site and month. Additional pastures were evaluated at the same time so that 16 clipped plots were used for each regression. Botanical composition of each plot was estimated by the dry weight rank method (t'Mannetje and Haydock 1963). Forage samples were composited by range site, ground to pass a 1 mm mesh screen in a Wiley mill and analyzed for crude protein and in vitro organic matter digestibility.

Data were analyzed using the General Linear Models Procedures of SAS (1989). Error mean squares were generated from a model containing animal class, month, year, and all associated interactions, and individual animal within animal class. This last component was used to test the effect of animal class on diet selection. Because animal class changed between years (i.e., 1993 calves became 1994 yearling heifers), the term for individual animal within animal class was deleted and the model rerun to produce estimable least squares means. Standard errors of the least square means were then corrected using the error mean square from the initial model. Mean separation was by least significant difference if a significant F-test was observed.

Results and Discussion

Botanical composition of the pastures was dominated by cool-season grasses with some warm-season grasses, annual grasses, sedges, and forbs present (Table 1). Shrub biomass was not estimated.

Table 1. Average botanical composition of available herbage on 2 representative range sites within the pastures sampled for diet quality. Shrubs were not included in the estimates.

	1993	1994
	---(% of biomass)---	
Cool-season grasses	54	61
Warm-season grasses	17	21
Annual grasses	3	1
Carex spp.	6	5
Forbs	20	12

Forage availability ranged from 1,129 to 2,047 kg ha^{-1} on 2 sites within the pastures (Table 2). Precipitation between the 2 years differed (Fig. 1) with resulting differences in available forage and herbage quality (Table 3 and 4).

Seasonal diet quality trends were observed for all animal classes, but dietary crude protein exhibited various interactions among animal class, month, and year ($P < 0.10$; Table 3). The only animal class -month combinations not differing in dietary crude protein between years were diets of calves, heifers, and cows in June and heifers in July.

Diets of calves and heifers generally had greater crude protein concentrations than

Table 2. **Herbage mass of 2 range sites within pastures sampled by esophageally cannulated cattle on 5 dates in 2 years. Standard error of the mean = 26.8, n = 20.**

	June	July	Aug	Sep	Oct
1993			(kg ha^{-1})		
Clay pan	2047	1762	1799	1754	1737
Silty-shallow	1426	1555	1590	1344	1363
1994					
Clay pan	1957	1967	1879	1803	1129
Silty-shallow	1507	2008	1490	1275	1393

Table 3. Least square means of dietary crude protein and during 2 growing seasons for 4 classes of cattle. Pooled standard error of the mean for diet crude protein = 0.08.

	June	July	Aug	Sep	Oct
1993			(% of organic matter)		
Calves	14.2^{a1}	12.6^{a}	10.9^{a}	10.8^{a}	8.9
Heifers	13.5^{a}	11.7^{ab}	10.8^{a}	9.1^{b}	8.9
Cows	11.8^{b}	11.2^{b}	9.9^{a}	8.8^{b}	8.7
Steers	9.8^{c}	9.8^{c}	8.3^{b}	7.8^{c}	8.5
Herbage	9.2	11.5	10.0	9.0	8.6
1994					
Calves	14.2^{a}	10.9^{a}	8.5^{a}	7.7^{a}	12.7^{a}
Heifers	14.3^{a}	11.0^{a}	9.0^{a}	7.6^{a}	12.3^{ab}
Cows	11.7^{b}	8.2^{b}	7.3^{b}	7.5^{a}	13.2^{bc}
Steers	11.1^{b}	8.2^{b}	7.2^{b}	9.6^{b}	13.6^{c}
Herbage	8.5	9.0	6.3	8.3	8.4

[1]Means within month by year with different superscripts differ by animal class ($P < 0.05$).
Significant effects in the model were animal class, $P < 0.01$; month, $P < 0.01$; animal class x month, $P < 0.01$; animal class x year, $P < 0.01$; month x year, $P < 0.01$, individual animal within animal class, $P < 0.01$, animal class x month x year, $P < 0.10$.

other animal classes, but differences decreased as the season progressed. During 1993, steer diets contained less crude protein than diets of other animal classes except at the October sampling, when there were no differences due to animal class. During 1994, crude protein concentrations of steer diets did not differ from those of cows except in September, when diets of steers had greater crude protein concentrations than any other animal class.

There were fewer differences among animal classes for in vitro organic matter digestibility (Table 4) than for crude protein. Digestibility did not differ ($P > 0.10$) among animal classes for the August 1993, July 1994, and October 1994 samples. Heifer diets were often lower in digestibility than calf diets, even when they did not differ in crude protein.

While general trends in diet quality throughout a growing season may be similar among animal classes, absolute values may be different. Animal class by month interactions for both crude protein and in vitro organic matter digestibility indicate that prediction of the diet quality of one class from another is not advised.

The differences in dietary selection between steers and cows may be related to more than gender. Physiological states and physical stature of these animal classes were quite different. They differed in energy needs as well as muzzle size. It is not apparent from this study what caused differences between cow and steer diet selection.

Several researchers have reported that diets of calves may differ in nutritive quality compared to older animals, but that this difference varies with forage conditions (Hodgson and Jamieson 1981, Le Du and Baker 1981). Ferrar Cazcarra and Petit (1995) reported that 7-month-old calves had higher fecal nitrogen than both 18-month-old heifers and adult cows. This occurred irrespective of sward height in pastures of orchardgrass (*Dactylis glomeratus* L.). These researchers suggested that calves ate smaller, shallower bites resulting in a diet consisting of more leaf with higher protein content than heifers or cows.

The choice of animal class to use for studies intended to rank varieties or forage treatments may be of limited concern, but it is critical to use the appropriate animal class when nutrient intake and digestion are being considered. For example, if mature steers had been used to estimate diet quality for yearlings during June 1993, crude protein would have been underestimated by 4 percentage units (9.8 vs 13.5%, Table 3) compared to using yearlings to collect diet samples. The subsequent error in nutrient intake and digestibility would be quite large. The heifers in this study were being used to estimate diet quality for steers grazing these pastures during this time period. Using heifer diet quality values resulted in crude protein intakes of 737 g day^{-1} for yearling steers. If we had used diet quality as collected by mature steers, our crude protein intake estimates would have been only 521 g day^{-1}. We might have suggested differing management strategies for these cattle based upon our erroneous results.

Crude protein levels of available forage were below that of all selected diets during June and October of 1994, indicating strong diet selection at these times (Table 3). Relationship of diet crude protein to forage crude protein during other months differed. In vitro organic matter digestibility of available forage was always well below that of diets (Table 4).

Table 4. Least square means of in vitro organic matter digestibility during 2 growing seasons for 4 classes of cattle. Pooled standard error of the mean for diet in vitro organic matter digestibility = 0.18.

	June	July	Aug	Sep	Oct
1993			(% of organic matter)		
Calves	74.3^{a1}	68.3^{a}	62.5	61.9^{a}	54.7^{a}
Heifers	66.5^{b}	62.5^{b}	59.8	58.6^{b}	56.6^{ab}
Cows	72.7^{a}	65.0^{bc}	62.4	58.6^{b}	50.7^{c}
Steers	69.3^{b}	67.9^{ac}	60.9	58.5^{b}	58.6^{b}
Herbage	52.4	52.6	49.3	49.5	46.9
1994					
Calves	68.5^{a}	61.2	58.7^{a}	60.6^{a}	62.1
Heifers	65.9^{a}	57.8	55.3^{b}	56.2^{b}	62.4
Cows	67.1^{a}	59.7	57.7^{ab}	58.7^{ab}	63.6
Steers	64.4^{a}	61.1	56.4^{ab}	58.1^{ab}	63.9
Herbage	52.5	51.4	47.5	51.3	50.2

[1]Means within month by year with different superscripts differ by animal class ($P < 0.05$).
Significant effects in the model were animal class, $P < 0.01$; month, $P < 0.01$; animal class x month, $P < 0.01$; animal class x year, $P < 0.10$; month x year, $P < 0.01$; animal class x month x year, $P < 0.05$; individual animal within animal class, $P < 0.01$.

Table 5. Least squares means of botanical composition of diets of cattle of 4 animal classes and total standing crop, June– October, 1993 and 1994.

	1993					1994						
	June	July	Aug	Sep	Oct	June	July	Aug	Sep	Oct	Mean	SEM
Number of samples in mean	(n)											
Calves	5	6	6	6	6	2	7	8	8	8		
Heifers	5	5	5	5	5	4	4	4	4	3		
Cows	6	6	6	6	6	6	6	6	6	6		
Steers	6	5	6	6	5	6	6	6	6	6		
Cool-season grasses (*abcd*)[1]	(%)											
Calves	45	74	96	73	61	69	70	67	78	86	72	1.1
Heifers	67	43	74	69	60	76	56	76	79	88	69	
Cows	50	70	90	84	58	67	62	82	68	88	72	
Steers	44	79	90	91	33	69	56	83	35	79	66	
Warm-season grasses (*cde*)												
Calves	0	2	1	2	6	3	3	6	4	1	3	.2
Heifers	2	8	11	10	6	4	4	3	5	2	5	
Cows	0	1	1	5	1	3	1	4	1	1	2	
Steers	1	0	5	3	2	5	2	7	0	1	2	
Annual grasses (*ace*)												
Calves	2	1	0	2	6	0	1	1	1	3	1	.1
Heifers	2	1	0	10	6	3	2	3	3	4	2	
Cows	2	2	1	5	1	4	1	0	0	5	2	
Steers	2	1	0	3	2	0	1	0	0	2	1	
Sedges (*acef*)												
Calves	5	6	1	2	17	5	6	6	1	3	5	0.4
Heifers	7	9	11	18	19	7	9	15	1	4	10	
Cows	2	8	4	7	19	2	8	4	1	4	6	
Steers	4	8	3	4	12	4	8	2	0	0	5	
Forbs (*ab*)												
Calves	3	1	1	1	0	6	2	0	0	1	1	0.1
Heifers	1	1	0	1	1	2	1	0	1	0	1	
Cows	2	1	0	1	0	1	0	1	0	1	1	
Steers	0	2	0	1	0	3	0	0	4	0	1	
Shrubs (*abcde*)												
Calves	44	16	1	22	14	22	20	20	15	6	18	1.1
Heifers	22	38	4	3	13	13	24	2	12	2	13	
Cows	44	19	4	2	1	21	32	8	29	21	18	
Steers	49	11	2	1	50	22	31	14	61	18	26	

[1]Within botanical species there were significant effects of a month, b animal type x month, c month x year, d animal type x month x year, e animal type, and f year.

During mid-summer, diet quality did not always differ from available forage quality. This may have been influenced by the relative contributions of warm-season grasses. Warm-season grasses comprised about 18% of the standing crop on 2 common range sites within the study area. Diets of cattle contained only 1.8 (steers) to 6.8% (heifers) warm-season grasses during the months of July to September. Cattle were not selecting warm-season grasses even though they had the potential to increase dietary protein concentrations by doing so. In contrast, digestibility of diets was greater than the digestibility of available forage. Warm-season grasses may have lower digestibility than cool-season grasses (Haferkamp et al. 2001) and this may indicate why warm-season grasses were not highly preferred species.

Cool-season grasses accounted for an average of 70% of all diets (Table 5). Shrubs, averaging 19%, were the next greatest component of the diet. Shrubs in the diet included winterfat (*Ceratoides lanata* (Pursh.) J.T. Howell), greasewood (*Sarcobatus vermiculatus* [Hook.] Emory.), shadscale (*Atriplex confertifolia* (*Torr. and Frem.*) Wats.), western snowberry (*Symphoricarpos occidentalis* Hook.), Wyoming big sagebrush (*Artemisia tridentata* Pursh. subsp. *wyomingensis* Beetle and Young), and fringed sagewort (*Artemisia frigida* Willd.). Forbs were a minor component of the standing crop and were, therefore, a minor component of the diet of this vegetation type.

Steer diets collected during September 1994 contained a large proportion of shrubs (61%). This resulted in a crude protein concentration that was 2 percentage units above other animal classes. We observed some instances of either steers or older cows leading the herd to what appeared to be preferred sites within the pasture, often with a component of winterfat in the community. Winterfat accounted for 18 to 86% of the 6 steer diet samples collected during September 1994. Possibly, this degree of shrub consumption would not be maintained throughout an entire day of grazing. However, increased shrub consumption through even a portion of the day could have a significant influence on the chemical composition of the diet, such that diets of other animal classes would not be well represented by the diet collected from these steers.

Mohammed et al. (1996) found dietary overlap between cows and steers to vary with season with a range from 70 to 90%. During spring and winter, cows consumed more grass and less forbs than steers. Although differences in shrub content in cow and steer diets differed at times, this difference was never greater than 4%, much less than that observed during our study. Diet composition in the study of Mohammed et al. (1996) was determined from fecal samples and would represent a longer gazing period than our samples.

We collected diet samples during a 30 to 45 min grazing bout on each of 2 mornings. Diurnal variation in diet selection may occur (Obioha et al. 1970, Van Dyne and Heady 1965), with potential compensation throughout the day for differences observed within the sampling period. However, it is common for researchers to use short-term grazing bouts to determine diet quality. Researchers utilizing fecal sampling to evaluate animal class comparisons (Langlands 1969, Mohammad et al. 1996) have also observed variation of diets among animal classes.

Conclusions

Alterations in botanical composition of diets of differing age and physiological classes of cattle can result in variations in chemical composition of those diets. Other factors are also involved in the variation in diet quality. Therefore, animals used to obtain diet samples on rangelands with diverse botanical composition should be of similar class as the animals being monitored for performance. This caution should be exhibited especially when forage availability is low, botanical diversity is high, and/or results are being used to estimate nutrient intakes.

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