Chemical Composition of Bighorn Winter Forages[1]

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Highlight

Chemical analysis revealed that the principal forage species which comprised more than 95% of the California bighorn winter diet in the Ashnola watershed (British Columbia) contained sufficient crude protein, fat, fiber, ash, nitrogen-free extract, and calcium for maintenance. However, by the same standards, all species and notably the grasses, were deficient in phosphorus. Low phosphorus and moderate calcium levels produced unfavorable calcium: phosphorus ratios by mid winter. Columbia needlegrass, a principal increaser species and an unimportant item in the bighorn winter diet, was inferior to the other species investigated. Bluebunch wheatgrass, a decreaser species and the most important bighorn food species, appeared to be the most nutritious grass.

California bighorn (*Ovis canadensis californiana*) in British Columbia utilize native grasses as principal winter forage (Blood, 1967; Sugden, 1961). Most browse species utilized as big game forage maintain a higher nutritive value during the winter months than do most naturally cured grasses.

Blood (1961) suggested that the main factor limiting the present California bighorn population in the Ashnola watershed is the shortage of the winter food supply resulting from summer use by cattle. Past overuse and present grazing by domestic livestock has caused the replacement of the climax species, bluebunch wheatgrass (*Agropyron spicatum*), by inferior species such as columbia needlegrass (*Stipa columbiana*), junegrass (*Koeleria cristata*), and sandberg bluegrass (*Poa secunda*) over much of the traditional bighorn winter range (Demarchi, 1965). The latter (increaser) species are less productive than the climax (decreaser) species. The present study was conducted in order to determine possible qualitative forage factors which may be limiting the bighorn population.

Study Area and Procedures

The Ashnola watershed, a tributary of the Similkameen River, is situated in south-central British Columbia. The Ashnola is in the transition zone between the Interior Plateau which lies to the north and the Cascade Mountain system which lies to the south, east and west. The region is included in the Ponderosa Pine and Douglas Fir Section of the Montane Forest (Rowe, 1959).

Eight forage species were collected at three periods between late August and mid-March from the one square-mile South Slope grassland which lies between 4,000 and 6,000 ft. Collections were made in August (late summer), November (late fall), and March (late winter). The samples, each consisting of no fewer than 10 plants of each species, were placed in forage drying ovens within 48 hr of collection and dried at 105 C to constant weight. The oven-dried samples were ground in a Wiley mill and passed through a 40-mesh screen. At least 20 g of each sample were placed into tightly stoppered, labelled bottles and stored in a desiccator.

A proximate analysis was conducted in duplicate using the methods of the AOAC (1960) with some modifications. Crude protein was determined by the macro-Kjeldahl method with two modifications: 40 ml of a 2% solution of boric acid with methyl red-methyl blue indicator was used to collect the distillate and the distillate was titrated against 0.011 N sulphuric acid. Crude fat, total ash, and crude fiber were determined according to the official procedures. Nitrogen-free extract (NFE) was determined as the difference between the sum of the percentages of protein, fat, fiber, and ash and 100.

Total mineral extracts for phosphorus and calcium determinations were prepared from the ashed samples used in the ash determinations (Ward and Johnston, 1960). The percentages of calcium present were determined by placing the mineral extracts in a flame spectrophotometer and plotting the readings against a standard curve. The percentages of total phosphates present were determined by the semi-micro method using a Beckman photoelectric colorimeter (Ward and Johnston, 1960).

The mean percentage values for crude protein, crude fat, crude fiber, total ash, NFE, calcium, and phosphorus determined for eight species at three sampling periods were arranged into a 3×8 completely random design. The data were transformed using the arc-sine transformation (Steele and Torrie, 1960). An analysis of variance for each of the seven nutritive constituents was arranged into a computer program and executed on an IBM 1620 computer. Confidence intervals of 95 and 99% were used to detect significant differences between species and between sampling periods.

Results

Winter Food Habits.—Blood (1967), employing grazed stem counts, analyses of rumen samples, and trailing feeding bighorn in newly fallen snow, determined that grasses made up an average of 72% of the Ashnola bighorn fall-to-spring diet, browse 24%, and forbs 4%. Bluebunch wheatgrass was the most important species followed by pasture sage (*Artemisia frigida*), sandberg bluegrass, junegrass, wyeth eriogonum (*Eriogonum heracleoides*), yarrow (*Achillea millefolium*), lupine (*Lupinus sericeus*), downy brome (*Bromus tectorum*), idaho fescue, and columbia needlegrass in decreasing order. An additional 12 species were recorded in trace amounts (less than 0.5% occurrence).

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Table 1. Seasonal variations in the chemical composition of eight bighorn winter forages, South Slope winter range, 1963–64 winter use period. (Percent composition based on oven-dried forage.)

Species	Sampling month	Crude fat	Crude protein	Crude fiber	Ash	NFE	Ca	P	Ca : P
Grasses									
Bluebunch wheatgrass	Aug.	8.61	6.72	26.35	9.18	49.14	0.31	0.06	5:1
	Nov.	7.94	3.29	31.10	10.72	46.95	0.47	0.05	9:1
	Mar.	6.53	2.83	35.13	9.03	46.48	0.23	0.01	23:1
Idaho fescue	Aug.	3.96	8.06	29.05	10.60	48.33	0.22	0.10	2:1
	Nov.	2.66	3.13	33.44	7.45	53.32	0.12	0.05	2:1
	Mar.	2.17	1.93	40.70	5.85	49.35	0.09	0.01	9:1
Junegrass	Aug.	3.24	5.25	36.93	9.28	45.30	0.15	0.07	2:1
	Nov.	3.24	3.79	38.77	8.65	45.55	0.11	0.03	4:1
	Mar.	3.85	2.37	35.17	7.00	51.61	0.09	0.01	9:1
Sandberg bluegrass	Aug.	7.82	11.01	24.82	10.10	46.25	0.45	0.12	4:1
	Nov.	4.85	6.51	31.33	8.20	49.11	0.20	0.06	3:1
	Mar.	2.25	2.02	37.56	4.49	53.68	0.04	0.01	4:1
Columbia needlegrass	Aug.	1.78	3.38	37.21	4.43	53.20	0.10	0.08	1:1
	Nov.	1.23	1.95	39.00	3.52	54.30	0.13	0.02	7:1
	Mar.	1.07	1.77	40.20	4.07	52.89	0.08	0.01	8:1
Forbs									
Yarrow	Aug.	5.30	5.95	23.25	10.96	54.54	1.19	0.09	13:1
	Nov.	4.28	5.63	23.63	12.34	54.14	1.45	0.05	29:1
	Mar.	4.50	5.97	21.90	12.51	55.12	1.25	0.04	31:1
Wyeth eriogonum	Aug.	2.54	6.64	21.29	4.75	64.78	0.72	0.08	9:1
	Nov.	4.16	5.71	20.18	5.44	64.51	0.86	0.05	17:1
	Mar.	2.57	6.01	34.16	3.28	53.98	0.40	0.04	10:1
Shrubs									
Pasture sage	Aug.	6.20	10.06	26.09	5.52	52.13	0.56	0.13	4:1
	Nov.	7.05	7.41	27.77	5.32	52.45	0.59	0.12	5:1
	Mar.	5.60	5.53	7.82	5.71	45.34	0.35	0.08	4:1

Chemical Composition of Winter Forages.—The decline in the crude protein content from August to March of the eight forage species which comprised more than 95% of the bighorn winter diet was found to be highly significant ($p < 0.01$) and species differences were significant ($p < 0.05$) (Tables 1, 2). Wyeth eriogonum showed the least change, dropping less than 10% of the initial value while idaho fescue was reduced to less than 25% of its late-summer value. Columbia needlegrass began and ended with the lowest protein content while pasture sage averaged higher than any other species. Sandberg bluegrass began with the highest protein level and averaged higher than all other grass species.

The seasonal variation in crude fat content was found to be not significant ($p < 0.05$). However, differences between species were highly significant ($p < 0.01$). Bluebunch wheatgrass and pasture sage maintained the highest crude fat levels while idaho fescue contained the lowest amount by late winter.

The relative increase in the crude fiber content of all species and the differences between species were found to be highly significant ($p < 0.01$). The forbs and shrub averaged lower than the grasses. Bluebunch wheatgrass contained less crude fiber than all other grasses while columbia needlegrass contained the highest late fall crude fiber content of all species.

Table 2. Analysis of variances for the nutrient contents of principal bighorn winter forages. Eight species sampled at three periods during the 1963–64 winter from the South Slope winter range. (Interactions were not separated from error degrees of freedom because only single samples of each species were analyzed at each sampling period.)

		Mean square values						
Source	df	Crude fat	Crude protein	Crude fiber	Total ash	NFE	Ca	P
Total	23							
		**	*	**	**	**	**	**
Species	7	7.98	4.87	10.62	8.02	6.28	2.43	0.09
Sampling months	2	n.s. 2.32	** 14.10	** 12.49	n.s. 2.29	n.s. 0.46	** 0.57	** 0.55
Error	14	0.66	1.18	1.63	0.66	1.25	0.08	0.02

** = differences highly significant ($p < 0.01$).
* = differences significant ($p < 0.05$).
n.s. = no significant differences.

No significant change was found in the seasonal ash content. However, species differences were highly significant ($p < 0.01$) varying from 12% in yarrow to 3% in columbia needlegrass during the late fall period. Among the grasses, bluebunch wheatgrass possessed the highest ash levels.

The seasonal variation in NFE was not significant ($p < 0.05$) while species showed highly significant differences ($p < 0.01$). Bluebunch wheatgrass and pasture sage possessed the lowest amounts of NFE while columbia needlegrass possessed more than any other grass and wyeth eriogonum rated higher than all species.

Both the seasonal decline and the difference in species calcium content were found to be highly significant ($p < 0.01$). The forbs and shrub species maintained the highest levels while the grasses exhibited the greatest seasonal percentage decreases of this mineral. Among the grasses, bluebunch wheatgrass maintained the highest calcium levels.

The seasonal decline in phosphorus and the difference between species were both highly significant ($p < 0.01$). The grasses contained the lowest amounts and were nearly depleted by the late winter period. The shrub and forb species contained almost the same percent of phosphorus at the end of the winter as found in the grass species during the late summer.

Discussion

Bluebunch wheatgrass contained the highest amounts of crude fat of all species examined, maintaining a relatively high level throughout the winter. Other important bighorn forage species such as pasture sage and sandberg bluegrass appear to be important sources of crude fat. However, the crude fat of pasture sage consists largely of essential oils which have little or no nutritive value and sandberg bluegrass is a relatively unproductive species. Columbia needlegrass, the principal increaser species, contained the lowest crude fat levels of the eight species examined.

Other important energy sources are the soluble carbohydrates of the NFE portion of the plants. All species studied possessed high amounts of NFE and maintained relatively high levels throughout the winter. (Differences between sampling months were found to be not significant.)

The National Research Council (NRC, 1957) recommends a minimum of 7.0 to 9.5% crude protein or 4.0 to 5.3% digestible protein in the daily diet for growth and gestation in domestic sheep. Loosli et al. (1949) state that through rumen fermentation, sheep can synthesize all of the known essential amino acids and that 33 to 50% of protein requirements can be met through the degradation of non-protein nitrogen, utilizing the nitrogen in the synthesis of protein. On this basis, bluebunch wheatgrass, pasture sage, and sandberg bluegrass, contain sufficient protein to meet requirements while columbia needlegrass does not.

The NRC (1957) recommends a ration containing 0.16 to 0.20% phosphorus for gestating and lactating domestic sheep. Cattle require similar levels (NRC, 1963). For growth and maintenance in the same species, the NRC recommends a minimum of 0.24 to 0.34% calcium. While the forage species which comprise the bulk of the winter diet appear to meet the recommended calcium levels, phosphorus is below the recommended level in nearly all cases. This was especially noted in the grasses where all species were almost totally leached of phosphorus by March. The relatively high calcium levels and low phosphorus levels distort the calcium : phosphorus ratios and the optimum 2 : 1 to 1 : 2 ratio established for domestic livestock is not realized (NRC, 1957, 1963).

Conclusions

Bluebunch wheatgrass, the most important item in the fall-to-spring diet of the Ashnola bighorn is the most nutritious grass. Any reduction of this species on bighorn winter ranges through annual cropping or overgrazing by livestock imparts a qualitative as well as a quantitative limitation on the bighorn population. It appears that any management effort designed to allow an increase in the Ashnola bighorn population should necessarily include a reduction in the use of the bighorn winter ranges by livestock and a restoration of bluebunch wheatgrass where overgrazing has occurred.

The effects of low phosphorus levels on the bighorn population requires further study.

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