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CHEMICAL COMPOSITION OF FORAGE LICHENS FROM NORTHERN SASKATCHEWAN AS RELATED TO USE BY BARREN GROUND CARIBOU

by

George W. Scotter, Range Ecologist,
Canadian Wildlife Service,
Department of Northern Affairs and National Resources,
742 Federal Building,
Edmonton, Alberta.

ABSTRACT

Samples of the more important forage lichens on the winter range of barren ground caribou were analysed for crude protein, crude fat, crude fiber, ash, calcium, and phosphorus. Twenty-five lichens and 8 vascular plants collected in June, September, and March were studied.

Lichens appear to have no nutritive qualities which especially adapt them as a food source for caribou. Their carbohydrate content is fairly high, but their crude protein, crude fat, calcium, and phosphorus content are low. Seasonal fluctuations in chemical composition are apparent. These fluctuations require additional study.

INTRODUCTION

The decline of the herds of barren ground caribou (Rangifer tarandus groenlandicus) in northern Canada has led to an active research program designed to provide data to ensure survival of this animal. One of the factors contributing to the decline may be the quality and quantity of forage available to caribou on their winter range. According to Kelsall (6) and others, lichens are utilized extensively by barren ground caribou during the winter and are the chief source of food upon which this animal depends at that season. No previous reports on the chemical composition of lichens in Canada are known and for that reason it is desirable to make our findings available.

METHODS

In order to obtain data on the chemical composition of lichens from the winter range in northern Saskatchewan, collections were made at three intervals, June and September, 1960 and March, 1961. All collections were made in the Stony Rapids and Black Lake region of northern Saskatchewan. Descriptions of the vegetation and geology of the area can be found in other publications (11, 15). For comparative purposes common vascular plants were also collected and analysed. Plant samples taken in June and September were collected over a wide area and in as many different habitats as possible. Collections during March were more confined because of the deep snow. The number of species available in March for analysis was also smaller. Only the leaves from the vascular plants and the portions of lichens showing no decay were removed for the samples. For the vascular plants the collection periods represent the height of the growing season (June), the onset of dormancy (September), and dormancy (March). The physiological activity of lichens at these periods is not known. The plants were later analysed by the Analytical Chemistry Research Service of the Canada Department of Agriculture using essentially the same methods as prescribed by the Association of Official Agricultural Chemists (1).

RESULTS

Results of the analyses (Table 1) show that lichens have no nutritive qualities which should especially adapt them for caribou forage. The lichen groups, listed in the probable order of caribou preference as suggested by limited food habit studies, show little consistency in protein content in relation to preference. Preferred species (Group I) contained only one-seventh as much protein than the least preferred lichens (Group V). This preference seems inconsistent with the requirements of the animals. Einarson (5) believed that black-tailed deer could not survive on forage below a 5 per cent crude protein level. The minimum digestible protein maintenance requirement for domestic livestock is 4.5 per cent (2). Arboreal lichens (Group IV), which are particularly important to caribou under severe weather conditions (12), are intermediate in protein content, but do not meet the 5 per cent level during the period of utilisation. In addition, the digestibility of lichen protein may be low. Recent Swedish experiments indicate that protein in lichens have a negative digestibility. Nordfelt et al. (7) reported, "... that reindeer lost approximately 3 grams digestible protein for each kg dry matter of lichens consumed". Shrubs were also intermediate in protein levels, but considerably lower than other species in regions farther south (4).

The fat or ether extract content was the highest in the arboreal lichens (Group IV) and lowest in Group III. Fat content was higher in the vascular plant group than in the lichen groups.

Fiber content was highest in the most preferred group of lichens. Reindeer appear to digest crude fiber especially well (7). A high fiber content broken down by rumen bacteria and protozoa would liberate large amounts of energy which would be advantageous to animals living under such extreme winter conditions. Lichen groups II and IV were low in fiber and the vascular plants were intermediate.

Ash, calcium, phosphorus, and nitrogen-free extract contents were variable. Ash content was highest in the vascular plants and lowest in lichen Group I. Calcium and phosphorus levels may be deficient in all groups with the possible exception of the evergreen shrubs. The minimum calcium and phosphorus requirements generally recommended for maintenance of domestic livestock under range conditions are .32 per cent and .17 per cent respectively. Beef cattle have a calcium requirement that varies from .14 to .37 per cent and phosphorus requirement that varies from .15 to .28 per cent, depending on sex, age, and condition of the animal (14). The optimum calcium-phosphorus ratio is 2:1 to 1:2, but should not exceed 5:1 (4). The ratio may be of no consequence as long as minimum requirements are met. Nitrogen-free extract was highest in the arboreal lichens (Group IV) and lowest in the leafy Peltigeraceae (Group V).

Spencer and Krumboltz (13), and Palmer (9) reported the analytical results from the same 21 Alaskan lichens, but they do not state the date of collection or the part of the plant analysed. Their results for the same or similar species are summarized in Table 2. Nutrient content of Alaskan lichens appear comparable to that of the same species in northern Saskatchewan. Palmer (8) also reported the results from Norwegian investigations, but no indication of the date of collection or part of the plant analysed was given.

Table 2. Chemical composition of Alaskan lichens (9, 13)

Sample	Percentage Composition					
	Moisture	Protein	Fat	Fiber	Ash	N.F.E.
Cladonia alpestris	12.35	2.18	1.92	43.98	2.33	37.29
Cladonia rangiferina	12.83	1.75	0.69	47.19	1.78	35.78
Cetraria nivalis	13.72	1.87	4.27	8.26	2.69	69.19
Stereocaulon tomentosum	12.66	5.44	1.94	27.32	2.09	50.55
Peltigera	13.41	17.12	1.12	21.93	7.91	38.51

It is evident that the plants most utilized are not always the most nutritious available. Cowan _et al_. (3) have also suggested that, "Nutritive quality and palatability are not necessarily related." Digestibility of plant species when eaten in combination may also be different than when eaten separately.

The major value of lichens to barren ground caribou probably lies in their carbohydrate content and not as a source of protein. The nitrogen-free extract content, thought to be highly digestible because of a low lignin content, increased during the winter while protein content decreased. These limited data suggest an inverse relationship between nitrogen-free extract content and the protein content of lichen forage.

In northern winters, one of the chief maintenance requirements may be for heat. The high crude fiber content in lichens, such as _Cladonia alpestris_, may explain their palatability to barren ground caribou. Rumen micro-organisms are able to break down crude fiber for their energy needs and at the same time liberate heat to the host.

Porsild (10) stated "... the nutritive value of the lichen plants remains unimpaired throughout the winter ...". Our data, however, do not support that statement. Arboreal and terrestrial lichens such as _Alectoria jubata_, _Evernia mesomorpha_, and _Cladonia alpestris_ appear subject to rather large fluctuations in nutritive values at different seasons. Seasonal fluctuations, however, require more study.

CONCLUSIONS

Although chemical analyses of plant foods must be interpreted with some caution, several management implications are suggested. It appears that lichens may have no nutritive qualities which especially recommend them as a food source. In general, the nutritive quality on the winter range of barren ground caribou in northern Saskatchewan is low. The carrying capacity of the winter range cannot, therefore, be based on total forage production alone. The nutrient content of the food plants and the nutrient requirements of the animals must be considered, also. Since the quality of the forage on the winter range is generally poor and quantity may be limited by snow cover, summer food may be more important as a factor of winter survival of caribou. A high plane of summer nutrition providing for adequate growth of calves and good fat deposits on mature animals may be needed to ensure overwinter survival.

Table 1. Chemical analyses of forage species from northern Saskatchewan

Group	Species	Date	Protein (N x 6.25)	Crude Fat	Crude Fiber	Ash	N.F.E.	Ca	P	Ca:P Ratio
			Percentage composition on dry matter basis							
I	*Cladonia alpestris*	June 3	2.74	1.96	31.38	1.23	62.69	0.11	0.07	1.6:1
		Sept. 6	2.11	1.63	45.04	0.92	50.30	0.09	0.05	1.8:1
		Mar. 15	2.27	1.26	33.99	0.85	61.63	0.10	0.05	2:1
	Cladonia rangiferina	June 6	2.52	0.72	43.79	0.90	52.07	0.10	0.06	1.7:1
		Sept. 13	3.18	0.66	37.66	1.00	57.50	0.10	0.06	1.7:1
	Group Average		2.56	1.25	38.37	.98	56.80	0.10	0.06	
II	*Cetraria nivalis*	June 6	2.57	2.60	7.19	1.96	85.68	0.31	0.06	5.2:1
		Sept. 13	2.63	2.30	7.88	2.21	84.98	0.38	0.06	6.3:1
		Mar. 15	2.33	1.43	7.46					
	Group Average		2.51	2.11	7.51	2.08	85.33	0.34	0.06	
III	*Stereocaulon* spp.	June 3	6.64	1.17	28.29	2.67	61.23	0.06	0.10	.6:1
		Sept. 8	7.91	1.03	24.58	1.40	65.08	0.05	0.13	.4:1
	Group Average		7.28	1.10	26.44	2.04	63.15	0.05	0.11	
IV	*Alectoria jubata*	June 5	6.26	1.00	6.62	1.08	85.04	0.10	0.08	1.2:1
		Sept. 13	4.51	0.44	5.72	1.23	88.10	0.15	0.10	1.5:1
		Mar. 15	3.98	0.43	5.36	1.04	89.19	0.13	0.09	1.4:1
	Evernia mesomorpha	June 3	5.14	3.50	10.09	1.83	79.44	0.07	0.06	1.2:1
		Sept. 7	5.41	3.52	10.71	1.83	78.53	0.08	0.06	1.3:1
		Mar. 15	3.94	3.16	12.52	1.42	78.93	0.08	0.05	1.6:1
	Usnea hirta	Sept. 9	5.45	4.87	7.10	1.41	81.17	0.19	0.07	2.7:1
		Mar. 15	4.59	5.70	6.93	1.41	81.37	0.23	0.05	4.6:1
	Group Average		4.91	2.83	8.13	1.41	82.72	0.13	0.07	

Table 1. (Continued)

Group	Species	Percentage composition on dry matter basis								
		Date	Protein (N x 6.25)	Crude Fat	Crude Fiber	Ash	N.F.E.	Ca	P	Ca:P Ratio
V	*Peltigera aphthosa*	June 3	17.79	2.04	23.62	1.96	54.59	0.10	0.14	.7:1
		Sept. 2	18.50	2.15	23.67	1.90	53.78	0.10	0.17	.6:1
	Peltigera canina	June 4	18.60	1.52	20.76	2.27	56.85	0.19	0.17	1.1:1
		Sept. 5	21.90	1.13	23.45	2.37	51.15	0.15	0.18	.8:1
	Peltigera aphthosa and *P. canina*	Mar. 15	19.61	1.54	24.75	1.90	52.20	0.13	0.15	.9:1
	Nephroma arcticum	June 28	13.30	3.57	27.94	2.61	52.58	0.05	0.16	.3:1
		Sept. 6	13.01	3.78	33.05	1.94	48.22	0.08	0.11	.7:1
	Group Average		17.53	2.25	25.32	2.14	52.77	.11	.15	
VI	*Arctostaphylos uva-ursi*	June 5	5.58	4.14	11.71	2.20	76.37	0.50	0.13	3.8:1
		Sept. 7	6.34	5.35	13.81	2.68	71.82	0.61	0.17	3.6:1
	Ledum groenlandicum	Sept. 9	10.45	4.98	24.66	2.68	57.23	0.48	0.19	2.5:1
		Mar. 15	8.74	4.63	23.87	2.24	60.52	0.57	0.15	3.8:1
	Vaccinium vitis-idaea var. *minus*	June 5	6.33	2.81	15.63	2.32	72.91	0.47	0.10	4.7:1
		Sept. 9	7.87	2.81	20.37	2.71	66.24	0.55	0.16	3.4:1
		Mar. 15	6.34	3.16	17.70	2.25	70.55	0.55	0.11	5:1
	Group Average		7.38	3.98	18.25	2.44	67.95	0.53	0.14	

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