

Digestibility of an Arboreal Lichen by Mule Deer

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Abstract

Arboreal lichens are commonly consumed by wintering cervids in temperate forests, but their nutritional value is poorly understood. The digestibility of an arboreal lichen (*Alectoria sarmentosa*) fed with alfalfa pellets to mule deer (*Odocoileus hemionus*) was estimated. The lichen contained 2% crude protein, 13.4% neutral detergent fiber (NDF), and 0.9% acid detergent fiber (ADF). Apparent digestibilities were very high for lichen dry matter (85.2%), NDF (91.9%), and cell solubles (84.2%). The apparent digestibility of protein was very low (-218.0%) and reflects the impossibility of balancing MFN losses with a forage containing such minimal nitrogen. This lichen can be an important source of energy to wintering cervids.

Key Words: digestion, forage quality, nitrogen, fiber, mule deer, lichens

Arboreal lichens are commonly consumed during winter by many ungulates in north temperate forests (Rochelle 1980, Hodgman and Bowyer 1985). Although lichens are assumed to be nutritionally valuable, in vitro digestibilities of arboreal lichens frequently are low (Rochelle 1980, Thomas and Kroeger 1981, Hanley and McKendrick 1983). However, lichen digestibilities determined with nylon bag techniques often exceed results from in vitro systems (Person et al. 1980). Lichens contain numerous antimicrobial compounds that may depress in vitro digestibilities (Person et al. 1980, Robbins et al. 1987b). To further complicate in vitro assessments, lichen digestibilities may increase as incubation times are extended to as long as 180 hr (Thomas and Kroeger 1981, Thomas et al. 1984). Because the same species of lichens consumed by free-ranging deer are often rejected by captive deer (Silver and Colovos 1957), in vivo digestibility of arboreal lichens is poorly understood. Consequently, the following digestion trials with *Alectoria sarmentosa* were undertaken to determine if this arboreal lichen is nutritionally important to wintering deer.

Methods

Approximately 60 kg of *Alectoria sarmentosa* was collected during October 1984 and May 1985 on Vancouver Island, British Columbia, Canada. Lichens were air-dried and all extraneous matter (bark, twigs, or leaves) removed. The lichens were stored in a dry, unheated barn prior to being fed. The digestion trials used 5 adult, female mule deer. Early attempts to feed a pure lichen diet were unsuccessful as the deer became anorectic. Attempts to force-feed 150 to 200 g lichens twice daily via a rumen fistula also failed. Consequently, the only useful technique to determine the digestibility in vivo was to feed a mixed diet and estimate the lichen digestibility by difference. Because it was hypothesized that the lichens would be highly digestible with relatively low levels of protein (Rochelle 1980), alfalfa pellets were chosen as the other diet component. The much lower dry matter digestibility and higher level of crude protein in the alfalfa pellets would be sufficiently different from the lichens to permit an estimate of lichen digestibility by difference even at relatively low levels of lichen intake. This approach assumes a constant digestibility of the alfalfa pellets with no interaction between the alfalfa pellets and the lichen.

Twelve captive deer were given access to small amounts of lichens and the normal alfalfa-grain pelleted diet for 2 weeks. Although some animals refused lichens, those that began eating lichens were separated into individual pens where lichen intake could be measured. The pellets offered were gradually reduced and lichen increased to determine maximum lichen intake while maintaining healthy deer. This level of lichen intake (25% of the diet) was continued as the alfalfa-grain pellets were switched to alfalfa pellets. Five digestion trials of each of the 2 diets (100% alfalfa pellets and 75% alfalfa pellets-25% lichens) were completed. Intakes of the 2 diets were approximately the same (1,200 g/day). Digestion trials were 7-day total collection trials with the animals confined to crates. Because of the time necessary to habituate the deer to lichens as well as establish a constant intake, the deer had been consuming lichens for approximately 1 month before collections began. Pretreatments for the alfalfa pellet digestion trials were 10 days with these trials immediately following the mixed diet trial.

Subsamples of the lichen and alfalfa pellets were taken daily and pooled for later analyses. Dry matter content of the feed during each trial was determined on samples dried at 100° C. Fresh fecal samples that were not contaminated with urine or hair were collected by rectally stimulating each animal to defecate twice daily during the trial. All other feces were dried at the end of the trial at 100° C, weighed, and discarded. The fresh feces were frozen (-20° C) until the end of the trial when a subsample was dried (40° C) and ground for all chemical analyses. Detergent analyses of the feed and feces were done sequentially and without sodium sulfite and decahydronaphthalene (Mould and Robbins 1981). Crude protein (N × 6.25) was determined using macro-kjeldahl procedures.

Results

The arboreal lichen was very low in crude protein and fiber (Table 1, Rochelle 1980). Virtually all of the lichen dry matter was soluble in neutral and acid detergent. The very small residual ADF was dark brown and suggestive of bark or other tree residue as the lichen is pale green. Lichens differ chemically from vascular plants in not having cellulose and lignin (Hale 1974), although allelo-

Table 1. Composition (100% dry matter basis) and digestibility (%) of alfalfa pellets, an arboreal lichen (*Alectoria sarmentosa*), and a mixture of the 2. Digestibilities are means ± 1 S.D.

Composition	Alfalfa pellets	Lichen	
Crude protein	19.8	2.0	
NDF	48.7	13.4	
ADF	35.0	0.9	
Lignin	9.3	—	
Cutin	2.1	—	
Digestibility	Alfalfa Pellets	75% Alfalfa Pellets 25% Lichens	Lichen
Dry matter	56.4 ± 1.2	63.6 ± 1.8 ¹	85.2 ± 3.5 ²
Crude protein	69.7 ± 1.7	60.3 ± 2.6	-218.0 ± 5.1
NDF	47.9 ± 1.3	51.6 ± 1.7	91.9 ± 3.2
NDS	64.5 ± 1.3	71.6 ± 1.7	84.2 ± 3.2

¹All mean digestibilities for the mixed diet are significantly different from the digestibilities of the alfalfa pellets (t-test, $P < 0.01$).

²Variance of the lichen digestibilities estimated as the variance of a linear combination (Dunn and Clark 1974).

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chemicals, such as soluble phenolics, could polymerize during detergent extraction to give a lignin artifact.

Dry matter, NDF, and cell soluble (NDS) digestibilities increased while crude protein digestibility decreased when lichens were fed with the alfalfa pellets (Table 1). The reduction in apparent protein digestibility is partially due to lichen's low crude protein content. Metabolic fecal losses can not be balanced with a forage containing 2% protein (Robbins 1983).

Discussion

The estimated dry matter, NDF, and NDS digestibilities for the lichen were very high and in general agreement with the earlier *in vitro* determinations (Rochelle 1980). Several areas of further study are warranted. The crude protein content (2%) is below the dietary level suggested as necessary for efficient rumen bacterial digestion of plant cell walls [6 to 8%, Van Soest (1982)]. Although many deciduous winter browse stems when consumed with lichens in a mixed diet would provide approximately the level of dietary protein recommended by Van Soest (Robbins et al. 1987a), many plant leaves contain tannins that could reduce protein availability in those forages below the recommended level (Robbins et al. 1987a). However, organic matter digestibility of a terrestrial lichen (*Cladonia alpestris*) containing 3.1% crude protein was not improved by the addition of urea (Jacobsen and Skjenneberg 1975). Secondly, the allelochemicals in lichens may restrict intake or require dilution by other dietary constituents to reduce their concentration to a level that is neither toxic to the rumen microbes nor to the animal. Thus, the digestibilities reported for the arboreal lichen in this study may be higher than would be observed with natural diets because the alfalfa contained adequate nitrogen and the lichen was a relatively small percent of the mixed diet. Finally, digestive synergism between lichens and other diet constituents should be explored (Rochelle 1980).

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