SEASONAL FEATURES OF NUTRITION AND NITROGEN METABOLISM IN MOOSE

Larisa P. Badlo and Anatoly F. Simakov
Institute of Physiology, Komi Scientific Center, Ural Division of the Russian Academy of Sciences, 167610, Syktyvkar GSP, Komi Republic, Russia

ABSTRACT: The seasonal concentration of nitrogen (N) and nitrogen metabolism in rumen digesta and blood serum were measured in two rumen-fistulated moose. Concentration of N and nitrogen metabolism in the rumen and blood varied seasonally. Concentration of protein N and metabolic processes in rumen digesta were highest in spring through summer and lower in autumn; the converse was true in blood serum. These seasonal differences were related to the variation in nutritional content of seasonal forage.

ALCES SUPPLEMENT 2: 19-22 (2002)

Key words: blood serum, moose, nitrogen, rumen metabolism

The moose is a ruminant that feeds primarily on arboreal plants. Many investigations of their seasonal feeding habits and digestion of natural forages have been conducted (Knorre 1959, Kaletskyy 1967, Sablina 1973, Timofeeva 1974, Kochanov et al. 1981). We conducted this study to measure seasonal concentration and metabolism of nitrogen in rumen digesta and blood serum, and to relate these data to the seasonal variation in forage quality and forage use by moose.

METHODS

This experiment used 2 rumen-fistulated male moose held at the Pechora-Ilych Reservation. The processes of rumen digestion and metabolism were studied during spring, summer, and autumn. The moose were kept on pasture during the experiment but were confined during sampling. They were maintained on food and water ad libitum. Rumen digesta samples were taken once daily. Blood samples were taken from the jugular vein before feeding. The chemical compounds of food, samples of rumen digesta, and feces were analyzed according to standard procedures. Total nitrogen was determined with the Kjeldahl method and protein nitrogen with the Barnshtein method; non-protein nitrogen equaled the difference between total nitrogen and protein nitrogen. Urea concentration was measured with the BIOTEST (CSSR). Amino nitrogen in the blood was measured according to the Uzbeckova method as modified by Chulkova. Fermentation activity of ALT and AST was measured according to the Roitmann and Frenkel unified method.

RESULTS AND DISCUSSION

Moose differ from domesticated ruminants because environmental influences dictate seasonal variation in forage availabilty, choice, and intake rate. Intake rates of moose are high during spring when buds and leaves appear (Knorre 1959). Biochemical analyses showed that leaves and young sprouts of aboreal plants are rich in nitrogen and crude protein during spring. For example, leaves of rowan-tree and willow have 3.28% nitrogen (20.5% crude protein), aspen leaves have slightly less nitrogen (3.06% or 19.1% crude protein), and, compara-

tively, birch leaves have lower nitrogen content (2.25% or 14.7% protein).

Young sprouts of these plant species have quite different concentrations of protein than their leaves; young sprouts of aspen have higher concentration of protein than those of birch and willow. The ratio of protein to non-protein nitrogen (PN:NPN) in young sprouts of birch was 3.0, and those of the willow and aspen were 2.8 and 1.7, respectively. Aspen bark is also eaten by moose during spring and has a protein concentration of 11%. Although the nutritional elements in bark are relatively low, moose consume it because of its high concentration of tannin.

Both arboreal plants and grass are consumed by moose during summer, but grass represents only 15% of the diet (Knorre 1959). During summer balance experiments, birch, rowan-tree, willow, and blossoming willow-herb (rose-bay) were consumed by moose. The concentration of crude protein in arboreal plants in July (13%) was lower than that in spring, although willow-herb had high concentration of crude protein (18.4%). Seasonal variation in intake rate helps explain why moose obtain more crude protein during summer than spring. For example, daily consumption of 11.5 kg of natural forage during spring includes 3.55 kg dry matter and 609.4 g protein; whereas, in summer they may consume 22 kg containing 6.6 kg dry matter and 946 g protein, about 2 times and 1.5 times as much dry matter and protein, respectively.

Variety in forage consumption declines in autumn versus summer. Leaves and sprouts of willow and birch, and pine branches, were consumed by the experimental moose during autumn. Our analyses indicated that autumn forage declined in nutrition; concentration of crude protein in willow and birch branches was only 7.2% and 6.6%, respectively. Although the concentration of protein was high relative to the PN:NPN ratio (Table 1), the lower absolute values of PN and the decline in daily intake rate to 8.3 kg yielded only 4.2 kg dry matter and 315 g crude protein daily.

Because the availability of crude protein in forage varies seasonally, similar variation in the intensity of rumen metabolism is likely. It is known that the forestomach of all ruminants plays a primary role in assimilation of nitrogen-containing substances. Protein is degraded to peptides, amino acids, and ammonia by enzymatic activity of microorganisms. The elements formed may be used for synthesis of bacterial protein, be

Table 1. The concentration of nitrogen-containing substances in the rumen digesta of moose.

Characteristics	Spring	Summer	Autumn
Nitrogen:			
Total N, g%	3.61 ± 0.13	3.50 ± 0.50	2.06 ± 0.17
Protein N, g%	2.40 ± 0.06	2.40 ± 0.12	1.40 ± 0.13
Non-protein N, g%	1.20 ± 0.12	0.99 ± 0.12	0.66 ± 0.18
Amino-N, mg%	29.30 ± 1.70	55.09 ± 6.20	37.50 ± 3.70
Urea, mg%	53.20 ± 4.90	15.20 ± 3.00	18.20 ± 2.00
Ammonia, mg%	13.20	5.30	6.80
Ratio (PN:NPN):			
In rumen	2.0	2.4	2.1
In food	1.8	2.2	2.5

partially absorbed through the rumen wall into blood, or flow to post-rumen sections of the digestive tract. Hydrolysis of non-protein nitrogen substances occurs in the rumen; formed elements may be used by microorganisms for the synthesis of amino acids and microbial protein. Simultaneously, nitrogen-containing substances may come to the forestomach from salivary secretions and blood through the rumen wall. Thus, the main role of the rumen in the metabolism of nitrogen-containing substances is to change or increase the amino acid compounds.

Saturation of rumen digesta by nitrogen-containing substances was revealed by our measurements of total protein, non-protein nitrogen, ammonia, and amino-nitrogen. The highest concentration of total nitrogen (3.61 g %) occurred in the spring-summer period. Variation in diet reflected a drop to 2.06% in autumn (Table 1). The concentration of protein and non-protein nitrogen in spring and summer was 1.5 times higher than that in autumn (Table 1), indicating the intensive hydrolytic and synthetic processes in spring and summer. Comparing seasonal PN:NPN ratios of rumen contents revealed increasing content of protein nitrogen from spring to summer and decreasing content from summer to autumn, reflecting the relative level of seasonal microbial activity in the rumen. During spring and summer, nutrient rich forage causes growth and reproduction of rumen microflora, producing valuable microbial protein in the rumen digesta. During autumn these processes slow, due to reduced protein intake, and protein content in the rumen subsequently declines.

The essential changes of amino-nitrogen, ammonia, and urea concentration in the rumen are peculiar to the nitrogen metabolism of moose. The highest concentration of ammonia and urea, and the lowest of amino-nitrogen, occurred during spring; the converse was true during summer. These characteristics had intermediate values during autumn (Table 2).

Thus, metabolism of nitrogen-containing substances in the rumen was dependent upon seasonal factors, as were hydrolytic processes in the rumen. Results from balance experiments indicated that the highest nutrient digestibility of protein occurred during spring-summer (70–75%), with measurable decline in autumn (52%). The nitrogen balance in summer was 64 g/d; as a

Table 2. The concentration of nitrogen substances (mg %) in blood serum of moose.

Characteristics	Spring	Summer	Autumn
Nitrogen:			
Total N	931	1001	964
Protein N	872	922	964
Non-protein N	59	79	30
Amino-N	3.3	4.1	4.3
Urea	30	20	19
Protein:			
Refractometry	6.45	6.80	7.04
ACT ed/ml	74.8	55.6	24.0
ALT ed/ml	57.8	36.1	11.0
Creatinine	2.1	3.1	

result, moose must intake great amounts of nutritive elements in autumn. This intake is indicated by the highest concentration of protein and amino-nitrogen in blood serum during autumn (Table 2). Similar changes were observed by LeResche et al. (1974). In autumn, protein metabolism in the blood declines, as does non-protein nitrogen, urea, and transaminase activity (Table 2). High creatinine concentrations in blood during autumn indicated increased metabolism processes in tissues.

REFERENCES

KALETSKYY, A. A. 1967. Moose food during the winter period and overall annual feeding patterns. Pages 216-221 *in* Biology and harvest of moose. Russia Publishing, Moscow, Russia. (In Russian).

KNORRE, E. P. 1959. Ecology of moose. Proceedings of the Pechoro-Ilych State Reserve 7:5–22. (In Russian).

KOCHANOV, N. E., G. M IVANOVA., A. E., WEBER, and A. F. SYMAKOV. 1981. The movements of wild animals (northern caribou and moose). Nauka, Leningrad, Russia. (In Russian).

LERESCHE, R. E., U. C. SEAL, P. D. KARNS, and A. W. FRANZMANN 1974. A review of blood chemistry of moose and other Cervidae with emphasis on nutritional assessment. Naturaliste Canadien 101:263–290.

SABLINA, T. B. 1973. Fundamental diet of moose in the natural environment. Pages 40-53 *in* The domestication of moose. Nauka, Moscow, Russia. (In Russian).

TIMOFEEVA, E. K. 1974. Moose: ecology, distribution, economic importance. Leningrad State Publishing House, Leningrad, Russia. (In Russian).