Seasonal variations in mineral status of reindeer calves from Elgaa reindeer herding district, Norway

Sesongvariasjoner i mineralstatus hos reinkalver fra Elgå reinbeitedistrikt

Hans Staaland[1] **and Stein Sæbø**[2]

[1] Department of Zoology

[2] Department of Botany, Agricultural University of Norway, 1432 Aas-NLH, Norway

Abstract: Botanical analyses of rumen content from reindeer calves slaughtered during the period August to April showed dominance of grasses (36%), lichens (30%) and woody plants (21%). Na content in rumen, bone, liver and muscle samples increased from August to April, whereas K and Mg decreased. It is suggested that the high level of K in summer forage increases Na excretion and drains the body reserves of this mineral. The body reserves of Na are apparently rebuilt through fall and winter.

Key words: reindeer, *Rangifer tarandus,* calves, minerals, seasonal

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Sammendrag: Botaniske analyser av vominnhold fra reinkalver som ble avlivet i perioden august til april viste dominans av gress (36%), lav (30%) og treaktige planter (21%). Innholdet av Na i vom, bein, lever og muskelprøver økte fra august til april, mens K og Mg avtok. Det blir antydet at det høye nivået av K i sommerbeite øker ekskresjon av Na og minsker kroppsbeholdningen av dette mineralet. Kroppsreservene av Na synes å bli bygget opp igjen i løpet av høst og vinter.

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Introduction

In 1979 the reindeer herds in the Elgaa reindeer herding district (east central Norway) were restocked with imported animals from Sweden. During the following winter several calves died in convulsions, later diagnosed as a possible effect of Mg deficiency.

The Elgaa area is dominated by washed out soils on sparagmite and granite rocks (Nystuen 1982) hence also the vegetation is dominated by forage thriving on poor soils. Scotch Pine, *Pinus sylvestris*, dominate large areas and the ground is covered by heather and lichens. Only locally stands of e.g. willow can be found.

It can therefore be assumed that the reindeer pasture plants are low in minerals and other nutrients. Symptoms of mineral deficiency could therefore presumably easily develop among reindeer in this area.

To further elucidate possible rôles of minerals as minimum factors in the reindeer pasture in the Elgaa herding district, systematic collection of forage plants for mineral analyses was started in the summer of 1980 and continued through 1981 to July 1982 (Sæbø and Staaland in prep.). In an attempt to observe possible changes in mineral status of live animals, 12 reindeer calves grazing natural vegetation were sacrificed from august 1980 to April 1981. The findings are reported in the present communication.

Materials and methods

Three reindeer calves, 3 - 11 months old, were killed at 4 different times of the year; August, September, December and April 1980-81. The animals were either shot in the field or killed immediately after being herded into corrals. The body weights of the calves ranged from 25 - 39 kg; mean 33 ± 4 (S.D., n=12). The animals were grazing natural vegetation in the Elgaa reindeer herding district in east central Norway (about 62°N, 12°E.)

Immediately after the killing representative subsamples of rumen content were filled into plastic bottles and a known quantity of formaldehyde added as a preservative. Botanical analyses of rumen samples were carried out at «Direktoratet for naturforvaltning» in Trondheim, Norway, according to methods described by Gaare and Skogland (1975). Thus 400 randomly chosen points in each sample were identified botanically and the results given as percentage score for each plant group.

From the same animals tissue samples of neck muscle, and samples of liver and bone were collected. The bone samples were 5 cm long sections taken from the middle part of the femur bone. This was completely cleaned from muscle and bone marrow tissue. Density of bone tissue was determined by weighing the sample submerged into glycerol of known density. Sampling of vegetation for chemical analyses was started in august 1980 and continued through the growing season of 1981 and the last sample was collected in July 1982. Detailed results from these analyses will be presented in a separate publication (Sæbø and Staaland in prep.).

Chemical analyses of all samples were carried out at the Chemical research laboratory, Agricultural University of Norway according to standard procedures as described by e.g. Staaland *et al.* (1984).

Results

No significant difference in botanical composition (except more woody plants in September than in other months) were found in rumen samples collected at different seasons (Fig. 1). The major dietary components were lichens (30%), grasses (36%) and woody plants (21%). No forbs were detected, but inspection in the field of large rumen samples in August revealed some seeds from cow-wheat *Melampyrum* sp. Content of water, ash, ether extracts, nitrogen free extract and crude fiber in rumen samples did not vary significantly by season, but protein was highest in August. Also fiber contents from December and April were different, but did not differ significantly (P>0.5) from August and September samples (Table 1).

As previously shown (Staaland and Jacobsen 1983), Na concentrations increased in rumen samples from August to April, whereas K decreased, thus creating an inverse relationship

Table 1. Nitrogen (Kjeldahl) and crude fiber (g/100 g DM ± S.D.) in rumen samples from Elgaa reindeer herding district (E.) compared to data from Hardangervidda (H.V.) and Svalbard (S). Figures in parentheses represent number of samples.

Tabell 1. Nitrogen (Kjeldahl) og fiber (g/100 g tørrstoff ± S.D.) i vomprøver fra Elgaa reinbeitedistrikt (E) sammenliknet med data fra Hardangervidda (H.V.) og Svalbard (S.). Tall i parentes er antall prøver.

		Summer/Fall	Winter
Nitrogen	H.V.*	4.4 ± 0.5 (38) (Aug. - Sep.)	3.8 ± 0.5 (55) (Dec. - May)
	S	4.9 ± 0.6 (24) (Aug. - Sep.)	2.3 ± 0.6 (42) (Dec. - May)
	E	5.5 ± 0.2 (3) (Aug.)	4.5 ± 0.4 (3) (Dec.)
	E	4.1 ± 0.3 (4) (Sep.)	3.6 ± 0.3 (3) (Apr.)
Crude fiber	H.V.*	17.9 ± 2.2 (35) (Aug. - Sep.)	17.5 ± 2.5 (55) (Dec. - May)
	S	16.5 ± 2.6 (24) (Aug. - Sep.)	24.9 ± 4.6 (42) (Dec. - May)
	E	25.6 ± 2.3 (3) (Aug.)	21.9 ± 2.4 (3) (Dec.)
	E	24.9 ± 3.5 (4) (Sep.)	35.1 ± 3.0 (3) (Apr.)

* From Reimers, 1980.

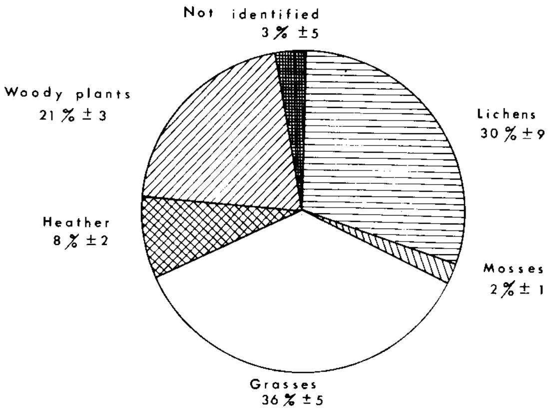

Fig. 1. Botanical composition of rumen samples (mean percentage score ± S.D.) from Elgaa reindeer herding district. Samples collected August, September, December and April 1980-81 (n=12).

Fig. 1. Botanisk sammensetning av vomprøver (gjennomsnitt prosent identifikasjon ± S.D.) fra Elgaa reinbeitedistrikt. Prøvene ble samlet i august, september, desember og april 1980-81 (n=12).

between these two elements. For P, Ca and Mg no significant variation by season was observed (Fig. 2).

Bone density increased from August to April (Fig. 3). There was a small increase in bone Na (n.s.) from August to April, but no change in Ca or P. Mg and K, however, decreased significantly through the same period ($P<0.05$).

Contents of minerals in liver and muscle (because of an accident when ashing) could only be calculated relative to the proportion of other minerals (Fig. 4). The relative content of Na apparently increased through the winter in both tissues, whereas Mg and K decreased in muscle tissue.

Discussion

The diet of the reindeer in Elgaa, as depicted from analyses of rumen content (Fig. 1), apparently changed very little from August through April. The dominance of lichens, grasses and woody plants indicates typical winter diet for reindeer (see e.g. Gaare 1968, Gaare and Skogland 1975). It might however be assumed that some easily digestible food items like mushrooms and forbs (e.g. cow-wheat) could be consumed in August without being represented in the rumen samples. This could explain the high nitrogen level in rumen samples from august (Table 1). The fiber content of rumen samples from Elgaa is high compared to samples from Hardangervidda and Svalbard, whereas nitrogen appears more equal.

The content of P and Mg in rumen samples did not show any seasonal variations, whereas Na and K exhibited large seasonal fluctuations. Na was low and K high in August and *vice versa* in April (Fig. 2). The most likely explanation is a high K/Na ratio in summer forage (Table 2) (Weeks and Kirkpatrick 1976 and 1978) which might increase Na losses through summer (Suttle and Field 1967). A K/Na ratio of 18 or higher in food have been shown to increase Na excretion

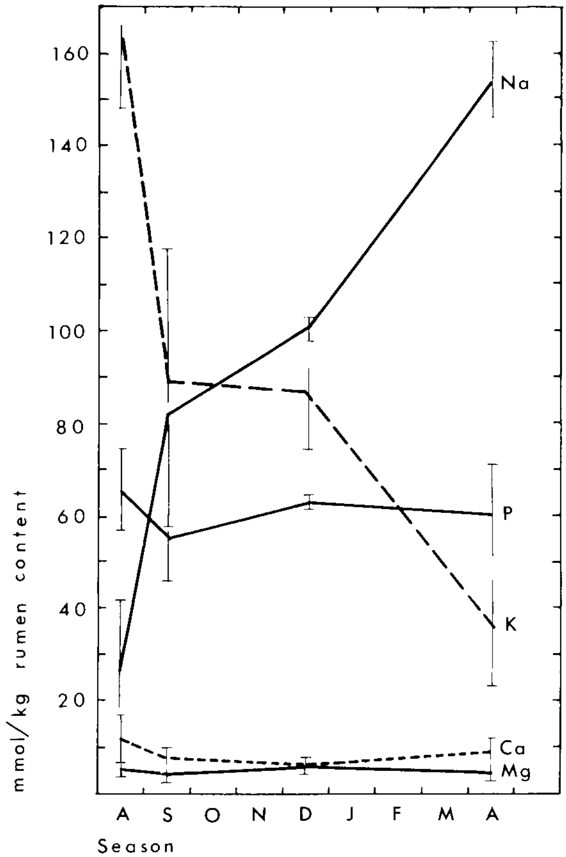

Fig. 2. Mineral content (mmol/kg content) in rumen samples from reindeer calves. Vertical bars indicate standard deviation of the means (n=3). S significant ($P<0.05$) differences between August and April samples.

Fig. 2. Mineralinnhold (mmol/kg innhold) i vomprøver fra reinsdyrkalver. Vertikale linjer viser standardavvik (n=3). S viser signifikante (P<0.05) forskjeller mellom august- og aprilprøver.

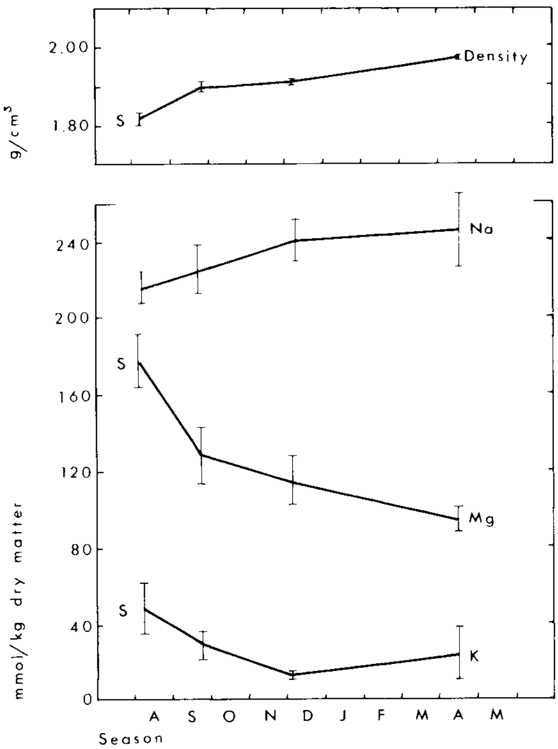

Fig. 3. Density (g/cm³) and mineral content (mmol/kg dry material) in femur bone from reindeer calves. Vertical bars indicate standard deviation of the means (n=3). S significant (P<0.05) difference between August and April samples. P is 3912±34 (n=12) and Ca 6304±60 (n=12) mmol/kg dry matter.

Fig. 3. Tetthet (g/cm³) og mineralinnhold (mmol/kg) i lårbeinsknokler fra reinsdyrkalver. Vertikale linjer indikerer standardavvik (n=3). S signifikante (P<0.05) forskjeller mellom august- og aprilprøver. P er 3912±34 (n=12) og Ca 6304±60 (n=12) mmol/kg tørrstoff.

(Maynard and Loosli 1969). As demonstrated in Table 2 summer forage can have K/Na ratios well above 18. Aquatic forbs and winter forage e.g., lichen, do have more favourable K/Na ratios. The same is true when e.g. grasses mature through the summer (Fig. 5). When the reindeer start feeding on fall and winter forage, the K/Na ratio is therefore more favourable and the animals can slowly rebuild depleted body reserves of sodium.

In the present study evidences for a better Na balance during winter is also found since there is increasing proportions of this mineral in bone, liver and muscle tissues (Fig. 3 and 4) (McDougall *et al.* 1974).

In this context it should be noted that the Na concentrations measured in lichens from the Elgaa area are unexpectedly high, considering the poor bedrocks and long distance from the sea. In Elgaa the Na content of lichens was 12 mmol/kg DM (Table 2) compared to 4 mmol/kg DM in lichens from Numedal (Staaland *et al.* 1983). Whereas precipitation south and west of Elgaa (Trysil and Narbuvoll) is low in sodium (Låg 1963, Anonymous 1983), some data indicate higher values to the east on the Swedish side of the border (Anonymous 1985). Lichen

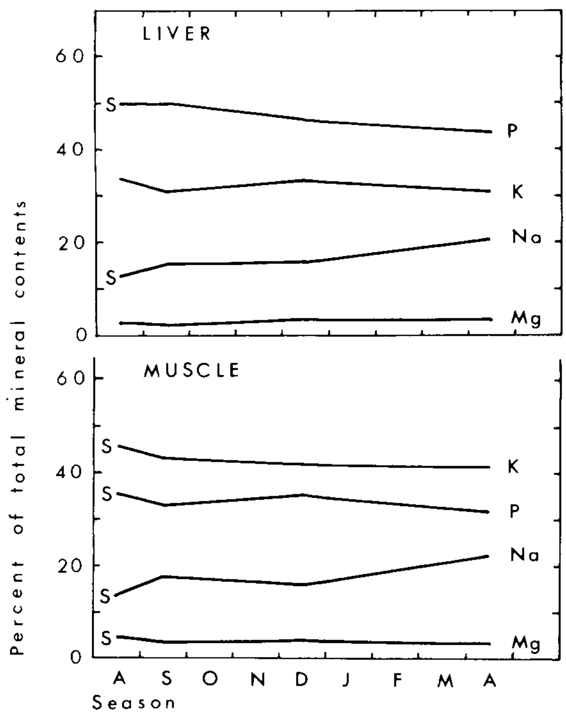

Fig. 4. Relative content of minerals in percent of total ash content of P+Ca+Mg+K+Na in liver and muscle samples from reindeer calves. S indicate significant (P<0.05) difference between August and April samples (n=3). S. D. < 4%. (Ca = 0.24 ± 0.02%, liver; 0.40 ± 0.03%, muscle, n=12, of total ash content of minerals).

Fig. 4. Relativt innhold av mineraler i prosent av totalt askeinnhold av P+Ca+Mg+K+Na i lever og muskelprøver fra reinsdyrkalver. S indikerer signifikante (P<0.05) forskjeller mellom august- og aprilprøver (n=3). S. D. < 4%. (Ca = 0.24 ± 0.02%, lever; og 0.40 ± 0.03%, muskel, n=12, av totalt askeinnhold av mineraler).

Table 2. Mean mineral concentrations (mmol/kg DM), nitrogen (Kjeldahl-N x 6.25) and crude fiber (g/kg DM) in different plant groups from Elgaa reindeer herding district. Figures in parenthesis range of variations.

Tabell 2. Gjennomsnitt mineralinnhold (mmol/kg tørrstoff), nitrogen (Kjeldahl-N x 6.25) og fiber (g/kg tørrstoff) i forskjellige plantegrupper fra Elgå reinbeitedistrikt. Tall i parentes er variasjonsbredde.

Plant group (Plantegruppe)	Na	K	K/Na	Ca	Mg	P	Nitrogen	Fiber	No. of samples	No. of species analyzed
Mushrooms	10	575	69	2	25	131	193	—	7	5
(Sopp)	(6-20)	(278-803)	(29-103)	(1-5)	(17-30)	(86-167)	(143-237)			
Lichens	12	42	3	19	10	15	43	202	17	7
(Lav)	(5-25)	(14-201)	(1-12)	(8-40)	(4-18)	(8-42)	(10-136)	(28-349)		
Mosses	13	134	15	88	44	46	59	356	4	2
(Mose)	(3-30)	(46-293)	(5-34)	(43-125)	(22-94)	(28-91)	(35-106)	(323-416)		
Horsetail	25	617	48	313	140	64	132	185	14	2
(Snellepl.)	(3-78)	(89-992)	(5-252)	(113-596)	(92-182)	(20-128)	(59-194)	(121-236)		
Grasses	10	330	45	49	36	42	110	268	55	10
(Gress)	(3-33)	(63-868)	(6-165)	(24-81)	(19-130)	(8-107)	(33-234)	(206-369)		
Heather	8	119	25	137	45	33	74	222	33	5
(Lyng)	(2-19)	(45-256)	(3-108)	(76-339)	(23-93)	(21-72)	(38-147)	(158-335)		
Woody pl.	10	177	28	133	75	59	122	177	46	4
(Treaktige pl.)	(2-24)	(46-507)	(4-155)	(69-307)	(27-115)	(12-159)	(35-252)	(107-341)		
Forbs terr.	31	691	30	172	115	99	185	185	9	2
(Urter, terr.)	(8-50)	(425-1080)	(14-72)	(104-314)	(43-159)	(48-173)	(83-322)	(127-248)		
Aquatic forbs	102	717	15	214	97	80	151	146	14	3
(Urter, vannpl.)	(18-311)	(285-1323)	(2-72)	(81-431)	(35-214)	(21-147)	(43-254)	(104-175)		
Roots, aquatic forbs	125	346	5	127	34	28	73	152	17	2
(Røtter av vannpl.)	(35-459)	(99-910)	(0.2-10)	(75-165)	(25-48)	(17-45)	(46-110)	(105-232)		

levels of other minerals, K, Ca, Mg and P (Table 2) do not differ from values found in e.g. Numedal (Staaland *et al.* 1983).

Levels of Mg in bone, liver and muscle tissues, as well as in blood plasma (Staaland *et al.* 1982) seem to decrease through the winter. This is consistent with low Mg levels in major winter diets like lichens (Table 2). It has indeed been shown that reindeer fed a poor lichen diet can develop extremely low blood plasma levels of this mineral (Bjarghov *et, al.* 1976). These findings seem to confirm the arly observation of Mg deficiency in dying reindeer calves during the winter of 1979 - 1980.

However, it has also been shown that dietary deficiency of P not only causes decreased levels of this mineral in bones and soft tissues of sheep, but also reduces bone Mg (Field *et al.* 1975). Since also P could be marginal element in winter forage it might also influence Mg levels in reindeer tissues. Low levels of body Mg could be detrimental in spring since high K levels in forage (Table 2, Fig. 5) can increase Mg excretion (Hvitsten, 1967; Suttle and Field, 1967). Bone Ca did not change significantly during the winter, and bone density increased (Fig. 3). This might indicate adequate Ca intake in the reindeer calves. In sheep, inadequate dietary Ca decreased bone density (Field *et al.*, 1975).

In conclusion, reindeer in the Elgaa herding district start early in the fall to feed on typical winter diets ingesting large proportions of lichens. During the summer they develop a Na deficit which is replenished in the course of fall and winter. Contrarily, Mg and possibly P deficits may develop during the winter.

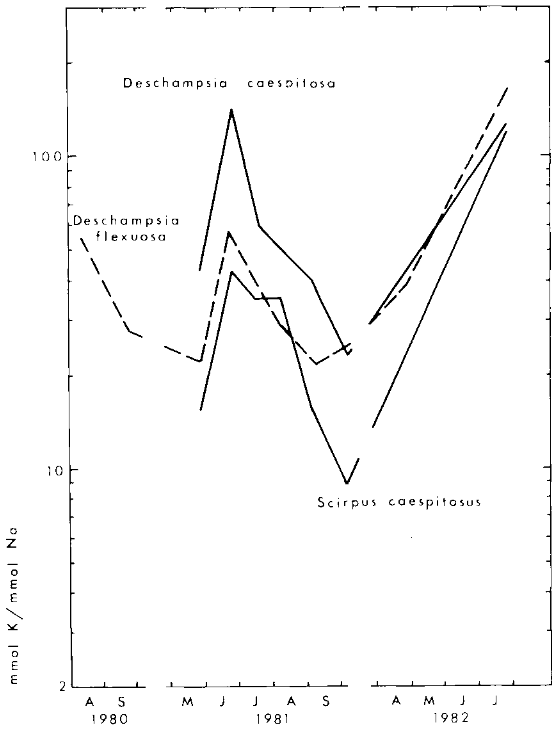

Fig. 5. Seasonal variations in K/Na ratio in 3 monocots (mmol K/mmol Na). From Sæbø and Staaland (in prep.).

Fig. 5. Sesongvariasjoner i forholdet mellom K og Na hos 3 gressaktige arter (mmol K/mmol Na). Fra Sæbø og Staaland (i prep.).

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