Diets of freely grazing and captive reindeer during summer and winter

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Summary: The chemical composition and nutritive value of different forage plants and commercial feeds of reindeer were studied by standard methods in the Finnish reindeer herding area during 1980-86. The nutritive values, particularly the protein and mineral contents, of ground lichens (*Cladina* spp.) and arboreal lichens (*Alectoria* spp.) were very low compared to forest wiregrass (*Deschampsia flexuosa)*, summer forage plants and commercial feeds. The crude protein and mineral content of reindeer summer food was very high. The energy content of lichens and commercial feeds was high and they are an important source of energy for reindeer in winter.

Key words: reindeer, forage plants, lichens, commercial feeds, seasons.

Rangifer, 9 (1): 17—34

Nieminen, M. & Heiskari, U. 1988. Vapaasti laiduntavien ja tarhaporojen ravinto kesä llä ja talvella.

Yhteenveto: Poron ravintokasvien ja kaupallisten rehujen kemiallista koostumusta ja ravintoarvoja tutkittiin vakiomenetelmin Suomen poronhoitoalueella vuosina 1980-86. Poronjäkälien (*Cladina* spp.) ja luppojen (*Alectoria* spp.) ravintoarvot ja valkuais- ja kivennäisainepitoisuudet olivat hyvin alhaiset verrattuna metsälauhaan (*Deschampsia flexuosa*), kesäravintokasveihin ja kaupallisiin rehuihin. Poronjäkälien ja kaupallisten rehujen energiapitoisuus oli kuitenkin korkea ja niistä poro saa nopeasti tarvitsemaansa energiaa talvella.

Rangifer, 9 (1): 17—34

Nieminen, M. & Heiskari, U. 1989. Fritt betande och inhägnade renars matsedel under sommar och vinter i Finland.

Sammandrag: Man har undersökt den kemiska sammansättningen och näringsvärdet av olika foderplanter och kommerciella fodermedel under åren 1980–86. Näringsvärdet, särskilt innhållet av protein i renlavar (*Cladina* spp.) och trädlavar (*Alectoria* spp.) var mycket lågt sammanliknat med smyla (*Deschampsia flexuosa)*, sommarbetes-planter och kommerciella fodermedel. Råprotein och mineralinnehåll i renenes sommarbetes-foder var mycket högt. Energiinnehållet av lavar och kommerciella fodermedel var högt och dessa är viktiga energikällor för renen i vintern.

Rangifer, 9 (1): 17—34

Introduction

Under natural conditions the diet of the semi-domesticated reindeer *(Rangifer tarandus tarandus L.)* is comprised of about 250 different plants, but an additional 200 may be acceptable. A total of 106 species have been listed as the most important, including 13 lichens, 36 grasses, 29 herbs, 14 woody species, 8 mushrooms, 5 shrubs and 1 horsetail (Skuncke 1958). In winter, the basic types of fodder are lichens and some wintergreen plants. Li-

chens are a food specific to the reindeer, and in many arctic areas lichens constitute nearly 2/3 of the entire vegetable mass consumed by the reindeer during the year. Reindeer prefer fruticose lichens of the genus *Cladina*. The most important wintergreen plants are forest wiregrass (*Deschampsia flexuosa*), cottongrass (*Eriophorum* spp.), horsetails (*Equisetum* spp.) and sedges (*Carex* spp.). Arboreal lichens (*Alectoria* and *Bryoria* sp.) are important in the central and southern parts of the reindeer herding area in Finland. Reindeer eat mushrooms towards the end of summer, the most important being *Boletus* sp.

The snow-covered period is nutritionally the most critical part of the year, and during recent winters many reindeer in Finland have been given supplementary rations of dry hay, grains, molasses and commercial feeds. The objective of this study was to compare the chemical composition and nutritive values of the most important forage plants and commercial feeds of the reindeer.

Material and methods

The forage plants of reindeer were collected during 1980–86 from different sampling areas in the reindeer herding area in Finland. The sampling was done during June and July. The chemical composition of different important forage plants were determined by standard methods (AOAC 1980). The feed values (feed units, energy values, digestible crude protein, digestible organic matter and digestible energy values) were calculated according to Salo et al. (1982).

Forage samples were collected from several different plants of each species. Grasses and forbs were cut at ground level. Only current annual growth was collected from the shrubs and live part from lichens.

Results

The dry matter (DM) (36–49 %), crude protein and crude fat contents of *Cladina* lichens was very low. Slightly higher values, especially dry matter (84–89 %) and crude protein, were measured in arboreal lichens (*Alectoria* spp.) growing on pines and birches (Table 1). Low crude fibre contents were measured in *Cetraria nivalis* and in *Alectoria* lichens. Sugar content was higher in ground than in arboreal lichens. The lowest sugar content was measured in *Cetraria nivalis*. N-free extract content of *Cladina* lichens was rather high. Slightly higher values were measured in *Alectoria* lichens (Table 1).

Table 1. Crude protein, crude fat, crude fibre, sugar and N-free extract contents (% DM) in different lichens from the Finnish reindeer herding area.

Tabell 1. Råprotein, råfett, växttråd, socker och kvävefria extraktivämnen (% av torrsubstansen) i olika lavarter inom Finlands renskötselområde.

Species	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Sugar (%)	N-free extract (%)
Cladina spp.	2.9–4.5	3.3–3.9	20.0–34.9	1.2–2.0	54.6–69.6
Cladina rangiferina	1.7–3.3	1.4	38.3	1.2	56.2
Cladina arbuscula	3.4	2.9	30.1	1.8	62.4
Cladina mitis	2.3–2.9				
Cladina stellaris	2.6–3.0	3.3	39.8	1.7	52.7
Cetraria nivalis	2.6	2.9	6.4	0.4	84.8
Stereocaulon spp.	6.2–7.1				
Parmelia spp.	7.0				
Alectoria spp.					
on pine	5.8	2.0	8.1	0.8	82
on birch	6.3	2.6	7.6	0.5	83

Table 2. Ash (% DM), mineral (g/kg DM) and trace element contents (mg/kg DM) in different lichens from the Finnish reindeer herding area.

Tabell 2. Aska (% av torrsubstans), mineraler (g/kg) och spårelementer (mg/kg) i olika lavarter inom Finlands renskötselområde.

Species	Ash (%)	Ca g/kg	P g/kg	Mg g/kg	K g/kg	Na g/kg	Cu mg/kg	Fe mg/kg	Zn mg/kg	Mn mg/kg
Cladina spp.	2.2–5.8	0.7–1.6	0.3–0.7	0.2–0.4	0.6–3.7	0.14–1.4	3.1–9.7	296–770	24.3–27.1	47.2–112.3
Cladina rangiferina	0.9	1.1	0.9	0.6	1.7	0.30	4.9	98.6	38.0	165.0
Cladina arbuscula	1.3	1.0	0.6	0.3	1.4	0.20	8.2	107.2	40.2	100.5
Cladina stellaris	1.2	0.7	0.7	0.3	1.4	0.17	3.9	112.1	28.6	70.8
Cetraria nivalis	2.2	3.2	0.4	0.6	1.8	0.40	3.3	163.2	39.1	119.9
Alectoria spp.										
on pine	1.6	0.7	1.1	0.3	3.8	0.3	3.8	172	41	90
on birch	1.6	1.1	0.9	0.5	2.8	0.7	6.0	295	82	66

The ash, Ca, Mg, P, Na, K, Cu and Zn contents in *Cladina* lichens were very low compared to other food plants (Tables 2 and 4). Similar low values were measured in arboreal lichens. Fe and Mn contents were higher in *Cladina* lichens than in *Alectoria* lichens.

The feed unit values of *Cladina* lichens were on average 3.9 kg/feed unit (NKF) and 1.4 kg DM/feed unit. The digestible organic matter in lichens was 691 g/kg DM and the crude energy content on average 18.8 MJ/kg DM. Slightly lower feed unit values were measured in *Alectoria* lichens growing on pines and birches (1.21 and 1.13 kg/feed unit, and 1.01 and 1.01 kg DM/feed unit, respectively). The digestible crude protein (DCP) content was virtually zero in *Cladina* lichens. Slightly higher values were measured in *Alectoria* lichens. The crude energy content in *Alectoria* lichens growing on pines and birches were on average 19.2 and 20.1 MJ/kg DM.

The crude protein content of reindeer summer forage plants varied slightly in different sampling areas and was 7.1–16.3 % DM in *D. flexuosa*, 8.5–18.2 % in *Equisetum fluviatile*, 9.3–21.7 % DM in *E. sylvaticum*, 8.9–14.7 % DM in *Carex* spp., 10.6–16.2 % DM in *Epilobium angustifolium*, 9.4–15.2 % DM in *Menyanthes trifoliata*, 10.3–25.5 % DM in *Potentilla palustris*, 11.3–23.0 % DM in leaves of *Betula pubescens*, 10.1–14.7 % DM in *B. nana*, 15.2–19.3 % DM in *B. tortuosa*, 9.3–20.2 % DM in *Salix phylicifolia* and 6.6–14.9 % DM in *S. lapponum* (Table 3).

The digestible crude protein values were high in reindeer forage plants during summer and values varied between 50 and 200 g/feed unit. The highest values were measured in *Potentilla palustris*, *B. pubescens*, *Equisetum* spp. and *S. phylicifolia* (Table 3). The crude fibre content varied between 3.1–41.2 % DM in different plants. The crude fat content varied between 0.7–15.5 % DM. The highest crude fat values were measured in *E. angustifolium* and *M. trifoliata*. The content of N-free extract varied between different plants (range 43.6–71% DM). The sugar content varied between 0.1–24.4 % DM, and the highest values were measured in *D. flexuosa*, *S. lapponum*, *B. nana*, *Carex* spp. and *Equisetum* spp. during summer.

The feed unit values of different plants var-

Table 3. Chemical composition (% DM) and feed unit values in different plants from the Finnish reindeer herding area.

Tabell 3. Kemiska sammansättning (% av torrsubstansen) och foderenheten i olika betesväxter inom Finlands renskötselområde.

Species	Locality	Water (%)	Crude protein (%)	Digestible crude protein g/feed unit	Crude fibre (%)	Crude fat (%)	N-free extract (%)	Sugar (%)	Kg/feed unit	Kg DM/ feed unit
Deschampsia flexuosa	Utsjoki	54.8–83.7	7.1–8.4	84–99	35.6–41.2	2.0–2.7	43.6–49.8	0.1–3.2	4.2–11.2	1.77–1.94
	Enontekiö	74.2	10.1	106	34.9	5.4	44.6	4.7	6.7	1.72
	Kemijärvi	50.0–77.9	10.8–16.3	61–136	8.9–22.3	1.2–9.2	54.0–71.0	6.8–24.4	3.35–4.68	0.97–1.82
Equisetum fluviatile	Kemijärvi	68.3–82.4	10.1–18.2	78–160	8.2–23.4	1.9–4.4	46.8–72.6	6.4–19.3	3.36–8.64	1.04–1.82
	Lohijärvi	18.9	8.5	81	27.1	2.6	43.9	5.8	2.60	2.10
Equisetum sylvaticum	Kemijärvi	52.8–74.9	9.3–21.7	72–168	8.6–25.4	3.2–11.0	49.0–65.2	6.6–20.8	3.13–7.08	0.94–1.87
Carex spp.	Kemijärvi	51.2–71.5	8.9–14.7	50–132	11.3–24.2	0.7–12.0	53.3–64.5	7.4–22.5	2.59–4.23	1.20–1.74
Epilobium angustifolium	Kemijärvi	54.8–79.8	10.6–16.2	67–123	9.9–26.8	2.9–15.0	51.0–66.4	7.8–16.8	2.74–8.26	1.04–1.69
Menyanthes trifoliata	Kemijärvi	51.4–64.7	9.4–15.2	67–101	10.8–23.7	1.2–15.5	47.5–69.5	7.2–10.6	2.71–4.73	1.09–1.94
Potentilla palustris	Kemijärvi	58.1–78.6	10.3–25.5	93–200	8.9–25.8	1.8–5.0	54.9–63.4	8.2–13.2	2.96–7.30	0.98–1.79
Betula pubescens	Kemijärvi	58.8–82.4	11.3–23.0	69–170	3.2–24.0	3.4–9.5	45.5–68.1	7.0–12.3	3.27–10.0	0.91–1.83
Betula nana	Enontekiö	58.7	12.6	81	17.7	5.8	60.8	3.6	4.9	2.00
	Kemijärvi	52.7–72.7	10.1–14.7	64–116	11.7–27.0	3.5–8.2	53.6–64.4	7.4–23.8	3.68–4.35	1.07–1.97
Betula tortuosa	Enontekiö	67.8	15.8	104	17.1	5.0	57.8	2.2	6.4	2.06
	Utsjoki	67.3–76.4	15.2–19.3	95–131	14.0–18.0	3.0–4.5	56.9–63.6	1.2–2.3	6.4–8.1	1.92–2.19

Salix phylicifolia	Enontekiö	66.0–66.1	15.3–17.4	108–137	14.4–21.2	3.0–3.2	53.4–62.1	1.2	4.0–4.5	1.36–1.53
	Kemijärvi	49.7–79.7	9.3–20.2	61–165	3.1–30.2	2.0–9.0	45.5–71.0	8.8–20.2	3.13–6.77	0.90–2.17
Salix lapponum	Kemijärvi	57.7–73.2	6.6–14.9	61–134	14.1–31.7	2.6–4.3	50.4–56.1	6.6–24.0	3.09–5.91	1.21–1.67
Betula and *Salix* dry leaves	Narkaus	23.9	14.2	112	13.7	6.0	61.4	12.4	3.21	2.45
	Jokijärvi	25.0	18.4	175	18.7	5.9	51.4	7.3	3.96	2.97
	Lohijärvi	25.3	14.3	125	16.0	5.4	59.0	8.6	3.62	2.71

ied between 2.6 and 11.2 kg/feed unit depending mainly on water content (range 50–84 %). The range of feed unit values calculated by dry matter weight was from 0.9–2.2 kg DM/feed unit (Table 3).

The ash content of the different forage plants was very high during summer and varied between 2.0–18.3 % in DM. The mineral and trace element values also were high, Ca ranging from 1.1–18.0 g/kg DM, P from 0.6–4.1 g/kg DM, Mg from 0.5–6.9 g/kg DM, K from 3.4–29.6 g/kg DM, Na from 0.02–7.45 g/kg DM, Cu from 0.7–13.1 mg/kg DM, Fe from 41–1852 mg/kg DM, Zn from 8–425 mg/kg DM and Mn from 72–2423 mg/kg DM (Table 4).

The crude protein content of dry leaves, harvested for winter feed, of *Betula* and *Salix* varied between 14.2–18.4 % DM (Table 3). The digestible crude protein content was high, ranging from 112–175 g/feed unit. The crude fibre content varied between 13.7–18.7 % DM, crude fat between 5.4–6 % DM, N-free extract between 51.4–61.4 % DM and sugar between 7.3–12.4 % DM. The feed unit values of dried leaves ranged from 2.45–2.97 kg DM/feed unit. The ash (range from 4.7–5.6 % DM), mineral and trace element contents of dry *Betula* and *Salix* leaves were very high (Table 4).

The commercial reindeer fodders used in Finland during winter contain mainly cereals, molasses, dry molasses pulp, grass meal, minerals and vitamins (Table 5). The crude protein content varies between 8.0–16.7 % DM, crude fibre between 14.7–23.3 % DM, ether extract between 2.2–6.9 % DM and N-free extract between 47.9–58.0 % DM (Table 6).

The feed unit values of commercial fodders vary between 1.3–1.76 kg/feed unit and between 1.2–1.53 kg DM/feed unit. The digestible organic matter content varies between 523–643 g/kg DM and the digestible crude protein content between 97–187 g/feed unit. The crude energy value of commercial fodders is on average 18 MJ/kg DM. The mineral and trace element values of commercial fodders are high compared to both lichens and green plants except for Mn which is higher in the latter (Tables 2, 4 and 7).

The feed components and chemical composition of the concentrates used for the feeding of the reindeer during summer in Kaamanen

Table 4. Ash (% DM), mineral (g/kg DM) and trace element contents (mg/kg DM) in different plants from the Finnish reindeer herding area.

Tabell 4. Aska (% torrsubstansen), mineraler (g/kg) och spårelementer (mg/kg) i olika betesväxter inom Finlands renskötselområde.

Species	Locality	Ash (%)	Ca g/kg	P g/kg	Mg g/kg	K g/kg	Na g/kg	Cu mg/kg	Fe mg/kg	Zn mg/kg	Mn mg/kg
Deschampsia flexuosa	Utsjoki	3.5–4.9	1.1–1.8	1.1–1.4	0.6–1.0	8.2–11.1	0.09–1.76	2.0–5.1	65–112	31–52	167–482
	Enontekiö	5.0	2.7	1.6	1.6	17.1	0.04	5.0	63	49	457
	Kemijärvi	2.3–9.2	2.0–12.6	0.8–2.4	1.7–5.4	3.6–17.2	0.02–4.94	2.1–8.9	57–528	48–185	186–1530
Equisetum fluviatile	Kemijärvi	6.4–15.6	5.0–11.5	1.8–3.4	2.8–5.0	10.3–24.6	0.04–4.90	0.8–6.3	75–1852	15–66	165–1530
		17.9	13.2	3.5	3.1	20.0	7.40	1.5	635	20	1232
Equisetum sylvaticum	Kemijärvi	3.7–14.6	1.9–11.7	1.4–2.8	0.8–4.8	4.9–18.7	0.03–7.45	1.3–6.0	54–1613	29–87	199–1844
Carex spp.	Kemijärvi	2.0–4.2	1.1–6.0	0.6–2.7	1.1–3.2	4.2–14.4	0.02–0.08	2.8–7.3	54–198	35–425	291–1259
Epilobium angustifolium	Kemijärvi	3.7–16.2	3.3–18.0	1.1–2.6	1.8–6.9	5.8–28.9	0.02–3.60	0.9–6.4	46–193	8–243	85–1147
Menyanthes trifoliata	Kemijärvi	2.5–9.1	4.5–12.5	1.0–3.0	2.0–4.3	4.1–25.8	0.02–0.25	2.0–4.8	66–535	51–189	293–1543
Potentilla palustris	Kemijärvi	2.7–13.2	2.9–7.5	0.7–3.2	1.9–4.1	7.1–17.3	0.02–0.05	2.1–5.6	73–339	31–124	72–1286
Betula pubescens	Kemijärvi	2.6–13.5	3.9–13.0	1.5–4.1	2.4–4.1	4.5–29.6	0.02–0.50	2.0–13.1	46–597	23–196	182–2423
Betula nana	Enontekiö	3.2	5.1	3.4	1.9	5.6	0.02	5.3	38	215	1177
	Kemijärvi	2.3–5.7	1.3–8.1	1.4–2.2	0.6–4.0	3.4–16.2	0.02–0.26	2.0–3.9	61–1498	25–161	367–2228
Betula tortuosa	Enontekiö	4.4	7.1	2.8	2.5	8.4	0.03	5.6	41	201	910
	Utsjoki	2.9–4.3	5.8–7.3	2.1–2.9	3.4–4.6	6.5–8.3	0.06–0.13	6.4–8.6	41–63	191–308	367–1042
Salix phylicifolia	Enontekiö	4.4–5.0	5.9–7.9	1.8–2.1	2.1–2.4	5.9–12.9	0.09	5.9–7.4	68–77	207–344	507–671
	Kemijärvi	2.4–15.6	1.9–12.0	1.0–3.1	1.9–3.5	3.6–19.7	0.02–1.35	0.7–4.8	85–659	15–388	134–833
Salix lapponum	Kemijärvi	3.8–18.3	1.3–17.2	1.2–1.9	0.5–5.2	9.0–16.9	0.02–0.05	0.7–6.2	51–223	12–38	138–1052
Betula and *Salix* dry leaves	Narkaus	4.7	9.9	2.9	5.2	6.3	0.15	1.5	88	188	161
	Jokijärvi	5.6	10.8	4.1	3.6	10.9	0.30	6.5	139	176	1063
	Lohijärvi	5.5	10.3	2.7	3.9	5.8	0.67	5.0	157	55	2111

Table 5. The feed components (% fresh weight) of the commercial reindeer fodders used in Finland during winter (Poroelo and Poroelo S produced by Suomen Rehu Oy, Poro-Ennätys by Rehumestari Oy, Poro-Rehu and Valtti by Hankkija Oy, Poro-Eväs by Lännen Tehtaat Oy and Poron-Herkku and Poron-Herkku 2 (year 1986) by Raision Tehtaat Oy).

Tabell 5. Sammansättning (% av färskvikten) av olika renfoder på vintern i Finland.

Components	Poroelo	Poroelo S	Poro-Ennätys	Poro-Rehu	Valtti	Poro-Eväs	Poron-Herkku	Poron-Herkku 2
Wheat							6	8
Oat	17	5	15	10			15	
Barley	11.6	5		3	0.5			
Barley bran						40		
Wheat bran	5	13	33.9	5	24		11	16
Oat bran	29	58	34	33	29	10	29	33
Molasses	5	5	4	6	6	25	6	6
Dry molasses pulp	23	5	3.75	24	5		20	25
Potato pulp					23			
Grassmeal	5	5					5	5
Fat							4	4
Rapeseedoil	1							
Rapeseed meal			5		1			
Soybean meal					2			
Hay (ground)				5		25		
Brewery grains				5.2				
Vegetable oil		1.0		2.5	3			
Seaweed concentrate		0.2						
Minerals	2.4	1.9	4.35	5.3	5.5		3.5	2.2
Vitamins	1	0.9		1	1		0.5	0.8

Reindeer Research Station in Finland are given in Table 8. The crude protein, crude fat, crude fibre, N-free extract and sugar contents in the concentrates are high. The ash content and mineral and trace element values are also high as compared with commercial winter fodder.

Discussion

The diet of freely grazing reindeer varies greatly through the seasons. Energy-rich lichens usually form the major component of reindeer's diet during winter and early spring. Lichens, however, are poor in protein and minerals, so that other foods, such as wintergreen grass (e.g. *D. flexuosa)*, is essential to maintaining the condition of reindeer during winter. Under very good lichen grazing conditions the reindeer gain fat, which means that there is surplus energy for its production. At the same time the lack of protein in the diet causes a breakdown of muscle (e.g. Nieminen 1980). Protein and minerals must therefore be stored by the reindeer during summer and autumn for the needs of the winter. During summer reindeer feed highly selectively. The chemical data presented here may therefore underestimate the quality of their summer diet.

Table 6. Dry matter (%), crude protein, ether extract, crude fibre and N-free extract contents (% DM) in different commercial reindeer fodders used in Finland during winter.

Tabell 6. Torrsubstans (%), råprotein, ether extraktivämnen, växttråd och kvävefria extraktivämnen (% av torrsubstans) i olika renfoder på vintern i Finland.

Fodder	Dry matter %	% of dry matter			
		Crude protein	Ether extract	Crude fibre	N-free extract
Poroelo	86.8	10.9	4.4	18.3	58.0
Poroelo S	88.0	8.0	3.4	23.3	57.3
Poro-Ennätys	90.0	16.7	4.3	19.9	47.9
Poro-Rehu	88.0	10.9	4.5	19.2	56.6
Valtti	89.5	10.3	5.6	14.7	56.0
Poro-Eväs	90.0	10.5	2.2	17.8	52.8
Poron-Herkku	88.2	13.1	6.9	13.5	57.7
Poron-Herkku 2	88.4	9.7	6.1	17.0	58.0

Table 7. Mineral (g/kg DM) and trace element contents (mg/kg DM) in different commercial reindeer fodders used in Finland during winter.

Tabell 7. Mineraler (g/kg i torrsubstansen) och spårelementer (mg/kg) i olika renfoder på vintern i Finland.

Fodder	Ash (%)	Ca g/kg	P g/kg	Mg g/kg	K g/kg	Na g/kg	Cu mg/kg	Fe mg/kg	Zn mg/kg	Mn mg/kg
Poroelo	8.4	12.5	7.5	2.6	34.2	3.6	19.6	457	327	98
Poroelo S	8.0	7.0	5.7	2.2	8.2	3.5	12.4	271	215	109
Poro-Ennätys	11.2	20.7	7.5	5.2	45.5	3.0	100.5	516	383	215
Poro-Rehu	8.8	13.9	7.3	3.0	34.6	3.7	21.1	423	396	103
Valtti	13.4	39.9	7.3	4.1	7.6	2.1	27.0	456	216	118
Poro-Eväs	16.7	3.3	4.8	2.8	21.3	2.2	7.4	183	67	99
Poron-Herkku	8.8	15.5	9.4	8.5	28.7	3.6	37.9	654	386	115
Poron-Herkku 2	9.2	12.3	6.6	2.2	13.8	4.1	30.0	461	257	96

The crude protein content of ground lichens (*Cladina* spp., *Cetraria nivalis)* was very low (1.4–4.5 % DM) consistent with previous observations (see Table 9). Pulliainen (1971) found a crude protein content of 3.5 % in the upper and 1.6 % in the lower sections of *Cladina alpestris.* Arboreal lichens (*Alectoria* spp. and *Bryoria* spp.) and *Stereocaulon* spp. had a somewhat higher crude protein content. According to Garmo (1986) *Stereocaulon* spp. also has higher levels of P, S, Cu and Mo compared to *Cetraria* spp. In the present study *Cetraria nivalis* contained more N-free extract, ash, Ca and Mg, but less crude fibre than *Cladina* lichens. Ca content of *Cetraria nivalis* was much higher than that of

Table 8. The feed component and chemical composition of the concentrates (produced by Raision Tehtaat Oy) used for the feeding of reindeer during summer in Kaamanen Reindeer Research Station in Finland.

Tabell 8. Sammansättning av renfoder på sommaren i Kaamanen Forskningstation i Finland.

Components	% in fresh weight	% in dry matter			
Soybean meal	2.2	Crude protein	20.7	Calcium	16.5 g/kg DM
Rapeseed meal	25.0	Crude fat	6.1	Phosphorus	7.3 g/kg DM
Mixed cereals	21.4	Crude fibre	13.9	Magnesium	3.6 g/kg DM
Oat bran	1.6	N-free extract	48.6	Potassium	15.3 g/kg DM
Grassmeal	25.0	Sugar	7.9	Sodium	3.5 g/kg DM
Fodder yeast	5.0	Ash	10.7	Copper	34 mg/kg DM
Fodder fat	2.6			Iron	468 mg/kg DM
Dry molasses pulp	11.4			Zinc	223 mg/kg DM
Wheat molasses	3.4			Manganese	120 mg/kg DM
Limestone	1.2				
Salt	0.2				
Selenium	0.2				
Trace elements	0.4				
Vitamins	0.4				

Cladina spp. (see table 10). This is consistent with the results of Garmo (1986). According to Lenvik (1980) Ca and P content of *C. stellaris* is 0.11 and 0.05 %. These values are slightly lower than ours. *Cetraria nivalis* and *Cladina* lichens have similar levels of crude fat. This disagrees with the results of Presthegge (1954) and Garmo (1986). According to Holleman and Luick (1977) reindeer preferred *C. alpestris* above all other lichen species and in no case did they select another species when *C. alpestris* was available. Reindeer consistently preferred *C. rangiferina* and *Stereocaulon* spp. over *Cetraria* spp. and *Peltigera* spp. Lichens contain low levels of most nutrients compared to grasses, except for crude fat, N-free extract, Fe and Se (see Garmo 1986). The digestible crude protein content of lichens is usually very low.

The reindeer's summer food contains about 22 % crude fibre, 15 % crude protein, 0.75 % Ca, 0.25 % P and 0.2 % Mg in DM. According to Steen (1966) the crude protein content of horsetail *(Equisetum fluviatile)* averages 15.4 % while the corresponding figure for sedges *(Carex* spp.) is 16.2 % in DM. Growing timothy *(Phleum pratense)* has 20.4 % crude protein in DM. Other grasslike plants or grass and herb pastures contain on average 15.4 % crude protein in DM. One of the best of these is bogbean *(Menyanthes trifoliata)*, the crude protein of which is about 22 % in DM. It is higher than measured in the present study (Table 11). The leaves of trees and bushes usually contain a higher proportion of crude protein than herbs and grasses. According to Isotalo (1971) the crude protein content is highest in grey alder *(Alnus incana)* (44.8 %) and white willow *(S. alba)* (38.3 %).

Mushrooms are a valuable nutritive and vitamin-rich fodder for reindeer during autumn and sometimes early winter. The crude protein content is on average 23 % in DM. Mushrooms consist mainly of water (90 to 93 %), but the dry matter is rich in proteins and enzymes according to Kreula *et al.* (1976). Their ash contains 3.1 % K and 0.47 % P (Isotalo 1971, Tables 12 and 13). Mushrooms contain much sugar, fat, and numerous vitamins, especially A_1, B_1, B_2, C and D. The cellular tissue of mushrooms is rather indigestible, and its presence reduces the nutrient value of this fodder (see Karaev 1961). According to Staaland and Saebo (1987) the fibre content of mushrooms is, however, very low and it is assumed that easily digestible mushrooms could

Table 9. Comparison of crude protein, digestible crude protein, crude fibre, crude fat, N-free extract and sugar contents (% DM) in different lichens. Results are collected from different studies.

Tabell 9. Jämföring med råprotein, smältbar råprotein, växttråd, råfett, kvävefria extraktivämnen och socker i olika lavarter. Resultaterna har samlats från olika forskningar.

Species	Crude protein (%)	Crude fibre (%)	Crude fat (%)	N-free extract (%)	Sugar (%)	Reference
Cladina spp.	2.8	34.1	2.6	56.9		Poijärvi 1945
	2.6	41.1	2.0	52.8		Høye & Tilrem 1951
	2.4	33.9	2.1	52.9		Gultsjak 1954
	2.6	35.3	2.5	55.7	0.03	Statens Husdjur-forsøk 1957–1960
	2.5	41.8	2.0	52.0		Rydberg 1960
	3.1	34.6		57.9		Holt 1961
	2.9	40.6				Rantanen 1963
	2.6	38.4	1.3	56.8		Scotter 1965
	3.0	32.3	4.2	57.9	0.08	Isotalo 1971
	4.5	34.9	3.9	69.6	2.0	Present study
Cladina rangiferina	2.9	40.7	0.7	54.8		Scotter 1965
	2.8	31.7				Solberg 1967
	2.2	42.3	1.6	51.4		Kelsall 1969
	2.8	28.3	0.6	66.9		Pegau 1969
	2.0	38.3	1.1			Pulliainen 1971
	1.7	61.7	0.7	35.0		Scotter 1972
	4.4	36.9	4.4	51.2	0.08	Isotalo 1971
	3.3	38.3	1.4	56.2	1.2	Present study
Cladina arbuscula	3.1	18.7				Solberg 1967
	1.9	44.0	1.2	50.8		Kelsall 1969
	2.3	23.6	0.9	72.1		Pegau 1969
	1.9	23.4	3.8	68.9	0.08	Isotalo 1971
	3.4	30.1	2.9	62.4	1.8	Present study
Cladina mitis	1.8	28.2				Solberg 1967
	2.5	28.0	1.7	65.6		Kelsall 1969
	1.5	54.7	1.5	41.4		Scotter 1972
	2.9					Present study
Cladina stellaris	2.4	33.9	2.1	52.9		Presthegge 1944
	2.4	36.8	1.6	58.2		Scotter 1965
	2.4	29.3				Solberg 1967
	2.3	37.1	2.2			Pulliainen 1971
	1.7	57.1	2.4	38.1		Scotter 1972
	2.8	36.5	4.6	53.7	0.08	Isotalo 1971
	2.8	44.5	1.5	49.1		Luick 1979
	3.0	39.8	3.3	52.7	1.7	Present study
Cetraria nivalis	2.0	6.4	4.2	85.4		Rydberg 1960
	2.5	7.5	2.1	85.3		Scotter 1965
	1.6		2.1			Solberg 1967
	2.5	5.1	4.0	86.4		Kelsall 1969
	1.4	11.2	2.2	83.7		Scotter 1972
	2.2	7.6	2.8	83.6	0.1	Isotalo 1971
	2.6	6.4	2.9	84.8	0.4	Present study

(Table 9 continues on next page)

(Table 9 continued)

Species	Crude protein (%)	Crude fibre (%)	Crude fat (%)	N-free extract (%)	Sugar (%)	Reference
Stereocaulon spp.	7.0	22.2	2.9	65.8		Rydberg 1960
	7.3	26.4	1.1	63.2		Scotter 1965
	6.7	18.1				Solberg 1967
	8.0	24.6	1.8	63.1		Kelsall 1969
	7.6	20.8	3.8	63.9	0.09	Isotalo 1971
	7.1					Present study
Alectoria spp.	6.3	8.1	2.6	83.0	0.8	Present study
Alectoria sarmentosa	3.9	1.9				Solberg 1967
	3.5	3.4	10.9			Pulliainen 1971
	5.5	13.1	6.4	73.1	0.07	Isotalo 1971
Bryoria fuscescens	4.9	5.9	0.6	87.4		Scotter 1965
	6.4	2.0				Solberg 1967
	4.8	39.7	2.6			Pulliainen 1971
	7.1	11.4	3.5	75.9	0.08	Isotalo 1971

be consumed without being detected in samples of rumen content.

About two thirds of the reindeer in Finland get their food on natural pastures during winter. The remainder seek out arboreal lichens in the cutting areas in the forests or are fed in corrals or in the field. Forests which are rich in arboreal lichens constitute mostly the restricting factor of carrying capacity in these areas, when ground lichens are reported to be a limiting factor in northern areas (see e.g. Nieminen 1980). Consequently many reindeer have been supplemented with dry hay, dry birch and willow twigs and leaves, grains, dry molasses pulp and commercial fodders during recent winters. During the snow-free period (about 160 days) the reindeer has usually small problems in fulfilling its nutritional requirements. However, it is suggested that the high level of K in reindeer summer forage increases Na excretion and drains the body reserves of this mineral. According to Staaland and Saebo (1987) the body reserves of Na are apparently rebuilt through autumn and winter.

The crude protein content of commercial fodders used for supplementing reindeer varies between 8–16.7 % DM. The mean of crude protein content in the most of common fodders is 10.5 % in DM. This is lower than the crude protein content in fodders given to reindeer and other cervids in the zoos and game farms, but equal with that of the reindeer commercial fodders used in Sweden (8 %), Norway (10.9 %) and Alaska (11 % min) (see Luick 1979b). Commercial reindeer fodders in Finland contain much molasses and for that reason, are rich in digestible energy. Digestibility of those fodders is good (Heiskari and Nieminen 1987). According to White and Cau (1975) lichens are also highly digested because reindeer/caribou both are able to increase their rumen retention time and to ferment lichens. That high digestibility, combined with a high carbohydrate content, makes lichens extremely high in digestible energy compared with other natural winter foods (see Russell and Martell 1984). Boertje (1981) concluded that energy was probably the limiting factor for reindeer in winter.

Table 10. Comparison of ash (% DM) and mineral contents (g/kg DM) in different lichens. Results are collected from different studies.

Tabell 10. Jämföring med aska (% av torrsubstansen) och mineraler (g/kg) i olika lavarter. Resultaterna har samlats från olika forskningar.

Species	Ash (%)	Ca g/kg	P g/kg	Ca/P	Mg g/kg	K g/kg	Na g/kg	Reference
Cladina spp.	2.8	1.3	0.6	2.2				Renbetes-markerna 1966
	3.9	0.4	0.2	2.0				Statens Husdjur-forsøk 1957–60
	2.5	1.0	0.6	1.6	0.5	2.0		Isotalo 1971
	1.1–2.6	0.8–1.6	0.4–0.9	1.7–2.0	0.3–1.0	1.9–5.0		SITRA, unpub-lished
	2.2–5.8	0.7–1.6	0.3–0.7	2.3	0.2–0.4	0.6–3.7	0.14–1.4	Present study
Cladina rangiferina	1.0	3.1	1.4	2.2	0.9			Egorov 1958
	1.0	1.2	1.1	1.1				Rydberg 1960
	1.4	0.5	0.6	0.8		0.8		Drury 1963
	2.8	0.8	0.8	1.0				Persson 1963
	0.8	0.6	0.5	1.2	0.2	1.3		Solberg 1967
	1.9	1.4	1.1	1.3				Rydberg 1968
	0.8	1.1	0.7	1.6	0.2	1.0		Pulliainen 1971
	0.9	1.2	0.4	3.0				Scotter 1972
					0.3	0.7		Scotter & Miltimore 1973
	3.1	1.4	0.7	2.0	0.3	2.5		Isotalo 1971
	2.1	1.0	0.9	1.1	0.4	2.0		Wielgolaski et al. 1975
	1.4	0.8	0.1	8.0	0.1	0.7	0.06	Luick 1979
	0.9	1.1	0.9	1.2	0.6	1.7	0.3	Present study
Cladina arbuscula	1.1	1.4	0.9	1.6				Rydberg 1960
		0.4	0.9	0.4		1.2		Drury 1963
	1.8	0.8	0.7	1.1				Persson 1963
	0.7	0.6	0.1	6.0		1.2		Solberg 1967
	1.7	0.9	0.6	1.5				Rydberg 1968
	2.0	0.6	0.4	1.5	0.8	1.9		Isotalo 1971
	0.8	0.3	0.4	0.8	0.2	1.4		Pakarinen 1981
	1.3	1.0	0.6	1.7	0.3	1.4	0.2	Present study
Cladina mitis	1.6		0.5					Solberg 1967
	0.8	1.2	0.3	4.0				Scotter 1972
					0.3	0.6		Scotter & Miltimore 1973
	0.9	0.6	0.5	1.2	0.3	1.4		Pakarinen 1981
Cladina stellaris	0.6	1.4	0.6	2.3	0.6			Egorov 1958
	3.0	1.0	0.8	1.3				Persson 1963
	1.1	0.7	0.4	1.8		1.2		Drury 1963
	1.0	1.0	0.6	1.7				Scotter 1965
	1.0	0.4	0.3	1.3	0.1	0.6		Solberg 1967
	2.3	1.0	0.7	1.4				Rydberg 1968
	1.9	0.5	0.2	2.5	0.3	0.7	0.05	Luick 1971

(Table 10 continues on next page)

(Table 10 continued)

Species	Ash (%)	Ca g/kg	P g/kg	Ca/P	Mg g/kg	K g/kg	Na g/kg	Reference
	0.8	1.0	0.8	1.3	0.2	1.0		Pulliainen 1971
	0.7	1.0	0.2	5.0				Scotter 1972
	2.4	1.1	0.8	1.4	0.3	1.8		Isotalo 1971
	0.9	0.2	0.4	0.5	0.2	1.4		Pakarinen 1981
	1.2	0.7	0.7	1.0	0.3	1.4	0.17	Present study
Cetraria	1.6	1.4	0.7	2.0				Presthegge 1954
nivalis	1.4	0.1	0.6	0.2		2.0		Drury 1963
	2.1	3.4	0.6	5.7				Scotter 1965
	1.2	0.8	0.2	4.0	0.1	1.0		Solberg 1967
	1.5	1.4	0.7	2.0				Rydberg 1968
		1.0	0.3	3.3	0.5	1.5	0.02	Luick 1971
	1.5	3.1	0.4	7.8				Scotter 1972
					0.7	1.0		Scotter & Miltimore 1973
	3.8	2.0	0.5	4.0	0.6	4.9		Isotalo 1971
	2.2	3.2	0.4	8.0	0.6	1.8	0.4	Present study
Stereocaulon	2.7	0.9	0.4	2.3		1.6		Drury 1963
spp.	3.3	0.5	0.9	0.6				Persson 1963
	2.1	0.6	1.2	0.5				Scotter 1965
	3.9	1.0	0.7	1.4	0.3	3.3		Isotalo 1971
Alectoria and	1.2	1.1	0.8	1.4				Rydberg 1968
Bryoria spp.	1.1–2.9	0.7–3.3	0.4–1.7		0.3–0.4	1.3–6.6		SITRA, unpublished
	1.6	0.7–1.1	0.9–1.1	0.8–1.0	0.3–0.5	2.8–3.8	0.3–0.7	Present study
Alectoria	1.2	2.1	0.5	4.2				Persson 1963
sarmentosa		1.1	0.7	1.6	0.2	1.0		Pulliainen 1971
	1.9	2.0	0.7	2.9	0.2	2.3		Isotalo 1971
Bryoria	1.6	1.2	1.4	0.9				Rydberg 1960
fuscescens	1.1	1.3	0.9	1.4				Scotter 1965
	1.5	1.0	0.6	1.7	0.3	3.6		Solberg 1967
		1.0	1.0	1.0	0.3	2.3		Pulliainen 1971
	2.1	1.3	0.6	2.2	0.3	2.4		Isotalo 1971

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Table 11. Comparison of chemical composition (% DM) in different plants. Results are collected from different studies.

Tabell 11. Jämföring med kemiska sammansättning i olika betesväxter. Resultaterna har samlats från olika forskningar.

Species	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Ash (%)	Ca/P	Reference
Betula spp.	4.6–23.9	–	–	1.4–7.7	1.5–2.0	SITRA, unpublished
	6.4–20.3	16.8–32.0	–	2.8–9.6	1.4–3.9	Isotalo 1971
	10.4–12.1	12.7–15.8	7.3–7.9	3.1–3.9	3.4–4.2	Scotter 1972
	18.0	16.0	8.0	4.0	–	Åhman & Åhman 1984
B. pubescens	4.9–22.4	–	–	1.4–7.7	1.1–3.3	SITRA, unpublished
	20.3	16.8	10.0	6.1	2.0	Isotalo 1971
	11.3–23.3	3.2–2.4	3.4–9.5	2.6–1.3	0.9–2.6	Present study
B. tortuosa	12.5	17.8	8.8	4.5	2.5	Isotalo 1971
	15.2–19.3	14.0–18.0	3.0–5.0	2.9–4.4	1.9–3.9	Present study
B. nana	23.9	–	–	4.6	0.9	SITRA, unpublished
	14.6	18.4	4.9	5.7	–	Isotalo 1971
	10.1–14.7	11.7–27.0	3.5–8.2	2.3–5.7	2.4–3.6	Present study
	15.6	16.2	7.2	3.3	–	Kelsall 1969
	16.0–26.0	13.2–16.3	2.2–3.5	2.8–4.6	–	Pegau 1969
Salix spp.	6.3–26.0	–	–	2.1–9.4	1.9–3.3	SITRA, unpublished
	12.6–38.3	17.9–27.0	–	4.5–6.1	1.0–2.0	Isotalo 1971
	9.7–10.9	12.4–13.5	2.9–4.1	5.3–6.2	2.9–5.5	Scotter 1972
S. phylicifolia	6.3–26.0	–	–	2.1–5.0	0.9–3.3	SITRA, unpublished
	22.7	27.0	2.4	5.0	2.5	Isotalo 1971
	9.3–20.2	3.1–30.2	2.0–9.0	2.4–15.6	1.9–3.9	Present study
	21.9	–	1.6	4.3	–	Kelsall 1969
	21.0	16.7	3.1	6.5	–	Pegau 1969
S. lapponum	6.6–14.9	14.1–31.7	2.6–4.3	3.8–18.3	1.0–1.1	Present study
Populus tremula	14.9–34.9	–	–	4.5–8.3	–	Present study
Sorbus aucubaria	11.3–20.2	–	–	6.3–8.6	–	Present study
	4.2–15.0	–	–	6.5	0.6–1.2	SITRA, unpublished
Carex spp.	8.3–19.8	23.3–50.1	–	3.7–8.0	1.5–1.8	Isotalo 1971
	8.3–8.7	–	–	–	1.5	Warenberg 1982
	12.9–16.6	24.5–18.5	1.3–1.8	4.0–4.3	–	Kelsall 1969
	8.9–14.7	11.3–24.2	0.7–1.2	2.0–4.2	1.8–2.2	Present study
Equisetum spp.	8.4–14.0	–	–	12.3–19.5	4.2–6.0	SITRA, unpublished
	13.2–21.5	21.9–30.0	–	13.2–15.9	3.1–3.3	Isotalo 1971
	11.4	18.8	3.3	–	–	Kelsall 1969
E. fluviatile	13.5–15.7	–	–	12.3–14.5	3.2–7.5	SITRA, unpublished
	13.2	21.9	2.8	14.8	4.5	Isotalo 1971
	8.5–18.2	8.2–27.1	1.9–4.4	6.4–17.9	2.7–3.5	Present study
E. sylvaticum	9.3–21.7	8.6–25.4	3.2–11.0	3.7–14.6	1.4–4.2	Present study
	17.2	20.1	2.1	15.9	3.5	Isotalo 1971

(Table 11 continues on next page)

(Table 11 continued)

Species	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Ash (%)	Ca/P	Reference
Menyanthes trifoliata	12.6–22.9	–	–	8.4–10.3	3.3–4.1	SITRA, unpublished
	21.5	23.9	2.1	8.2	4.5	Isotalo 1971
	18.2	–	–	–	1.6	Warenberg 1982
	9.4–15.2	10.8–23.7	1.2–15.5	2.5–9.1	4.2–4.5	Present study
Epilobium angustifolium	25.3	–	–	5.4–10.3	1.4–1.7	SITRA, unpublished
	16.2	17.4	7.0	6.7	3.2	Isotalo 1971
	13.4	27.1	3.1	6.6	–	Kelsall 1969
	10.6–16.2	9.9–26.8	2.9–15.0	3.7–16.2	3.0–6.9	Present study
Potentilla palustris	10.3–25.5	8.9–25.8	1.8–5.0	2.7–13.2	2.3–4.1	Present study
	18.8	17.5	3.1	5.1	–	Pegau 1969
Deschampsia flexuosa	6.7–10.7	–	–	4.1–5.3	0.9–1.1	SITRA, unpublished
	10.3	33.9	–	8.5	1.5	Isotalo 1971
	9.4–10.9	–	–	–	–	Warenberg 1982
	7.1–16.3	8.9–41.2	1.2–9.2	2.3–9.2	1.4–5.2	Present study
Vaccinium myrtillus	7.6	30.0	3.0	5.5	5	Isotalo 1971
	6.6	–	–	–	4	Warenberg 1982
Boletus spp.	18.4–24.7	–	–	6.3–7.8	0.1–0.2	SITRA, unpublished
	24.6	13.1–23.1	–	8.1	0.5	Isotalo 1971

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Table 12. Comparison of chemical composition (% DM) of different mushrooms. Results are collected from different studies.

Tabell 12. Jämföring med kemiska sammansättning i olika svampar. Resultaterna har samlats från olika forskningar.

Species	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Sugar (%)	Reference
Boletus sp.	24.6	17.1	7.2	0.16	Isotalo 1971
Leccinum scabrum	21.9	18.1	7.4	0.15	Isotalo 1971
	45.0	–	5.9	–	Karaev 1961
Suillus luteus	19.2	17.4	8.3	0.10	Isotalo 1971
	22.0	–	3.0	–	Kurkela 1972
	20.9	–	–	0.15	SITRA, unpublished
Leccinum versipelle	25.0	23.1	5.9	0.31	Isotalo 1971
B. edulis	37.0	–	2.0	–	Kurkela 1972
	43.9	–	6.2	–	Karaev 1961
	32.0	–	1.6	–	Aalto & Kreula 1972
S. variegatus	18.4	–	–	–	SITRA, unpublished
Lactarius sp.	20.7	13.4	6.9	0.06	Isotalo 1971
L. rufus	21.5	13.1	6.9	0.04	Isotalo 1971
L. torminosus	20.0	15.3	6.9	0.08	Isotalo 1971
	19–21	–	2–3	–	Kurkela 1972
	22.0	–	1.9	–	Aalto & Kreula 1972
L. trivialis	21.1	11.6	6.9	0.07	Isotalo 1971
	28.0	–	2.1	–	Aalto & Kreula 1972
L. deterrimus	38.0	–	7.0	–	Kurkela 1972
Russula sp.	20.5	16.0	3.8	0.05	Isotalo 1971
R. paludosa	23.5	13.5	9.8	0.06	Isotalo 1971
R. vinosa	19.1	19.3	3.8	0.07	Isotalo 1971
R. emetica	18.8	15.3	3.8	0.02	Isotalo 1971
Gyromitra esculenta	31.0	–	3.4	–	Kreula et al. 1976

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Table 13. Comparison of ash (% DM), mineral (g/kg DM) and trace element contents (mg/kg DM) in different mushrooms. Results are collected from different studies.

Tabell 13. Jämföring med aska (% av torrsubstansen), mineraler (g/kg) och spårelementer (mg/kg) i olika svampar. Resultaterna har samlats från olika forskningar.

Species	Ash (%)	Ca g/kg	P g/kg	Mg g/kg	K g/kg	Cu mg/kg	Fe mg/kg	Zn mg/kg	Mn mg/kg	Reference
Boletus sp.	8.1	2.4	4.8	0.8	28.8	–	–	–	–	Isotalo 1971
Leccinum	8.9	3.1	4.4	0.8	25.3	–	–	–	–	Isotalo 1971
scabrum	9.0	–	–	–	–	–	–	–	–	Karaev 1961
Suillus	8.9	7.0	5.0	1.0	27.4	–	–	–	–	Isotalo 1971
luteus	6.3	0.8	5.0	–	22.0	–	–	–	–	SITRA, unpublished
	8.0	0.10	–	0.76	37.0	14	52	115	3.0	Kurkela 1972
Leccinum versipelle	7.4	2.5	4.5	0.7	23.0	–	–	–	–	Isotalo 1971
B. edulis	–	0.12	–	0.5	29.0	24	49	72	18.0	Kreula et al. 1976
	8.0	–	–	–	–	–	–	–	–	Kurkela 1972
	8.1	–	–	–	–	–	–	–	–	Karaev 1961
	8.2	–	–	–	–	–	–	–	–	Aalto & Kreula 1972
S. variegatus	6.4	0.6	5.6	0.9	24.5	–	–	–	–	SITRA, unpublished
	–	–	–	0.55–1.21	–	6–28	1200–3200	53–93	6–63	Ohtonen 1982
Lactarius sp.	7.6	1.7	4.4	0.8	26.3	–	–	–	–	Isotalo 1971
L. rufus	9.8	1.3	4.0	0.8	30.2	–	–	–	–	Isotalo 1971
	–	–	–	0.53–0.94	–	9–20	42–91	65–93	19–27	Ohtonen 1982
L. torminosus	7	0.09–0.11	–	0.74–1.13	21.5–27.0	8–10	42–67	70–89	60–80	Kurkela 1972
	8.4	4.1	4.0	0.8	23.2	–	–	–	–	Isotalo 1971
	6.6	–	–	–	–	–	–	–	–	Aalto & Kreula 1972
L. trivialis	–	0.13	–	0.98	26.0	26	34	91	14	Kurkela 1972
	5.1	1.30	4.4	0.9	24.5	–	–	–	–	Isotalo 1971
	8.6	–	–	–	–	–	–	–	–	Aalto & Kreula 1972
L. deterrimus	8.0	–	–	–	–	–	–	–	–	Kurkela 1972
Russula sp.	10.1	4.7	4.4	0.9	35.7	–	–	–	–	Isotalo 1971
R. paludosa	12.1	2.1	3.9	0.9	35.8	–	–	–	–	Isotalo 1971
R. vinosa	7.3	8.0	4.7	0.8	33.5	–	–	–	–	Isotalo 1971
R. emetica	10.9	3.9	4.6	1.1	37.9	–	–	–	–	Isotalo 1971
Gyromitra	–	0.12	–	1.0	44.0	85	140	110	26	Kreula 1976
esculenta	10.2	–	–	–	–	–	–	–	–	Kreula et al. 1976

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