Evaluation of silage diets offered to reindeer calves intended for slaughter. II. Feeding of silage and concentrate from January to March

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Abstract: An experiment involving 56 male reindeer calves, with a mean initial live weight of 39 kg (SD=4.6), was undertaken to evaluate the effect of the concentrate:silage ratio on the performance during feeding to slaughter. Forty four of the calves were divided in four groups, two groups each being allotted to diets with low, 60% (LC), or high, 80% (HC) proportions of a commercial pelleted feed. The remaining twelve calves were slaughtered at the start of the experiment. The experimenral period lasted from January to March. The proportions of concentrate to silage were based on the dry matter (DM) content. The silage, 44% DM, was made from the primary growth of a predominantly grass sward preserved as plastic-wrapped big bales. Animal health was good throughour the experimenr. Small amounts of lichens were mixed into the diets during the first rwo weeks of feeding and may have contributed to the lack of adaptational problems. The mean daily intakes of DM and metabolisable energy were higher ($P<0.01$) for calves offered the HC-diet. Despite the higher feed intakes, the increased proportion of concentrate in the diet did not significantly alter live weight gains or carcass weight gains. However, the greater fat deposition ($P<0.05$) and better carcass gradings indicated a better condition of the animals at slaughtet when less silage was fed. This experiment was the the final part of a three year study of silage based diets for reindeer intended for slaughter and the general conclusion is that the best role of grass silage of this quality is as a limited part of the ration. The silage may, however, play an important role during the adaptation period and further detailed studies are needed to evaluate the applicability of silage as a part of the diet to reindeer.

Key words: *Rangifer tarandus tarandus*, feed intake, weight gain, dressing percentage, visceral organs, abdominal fat.

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Introduction

Data from our previous studies on silage-based diets for reindeer intended for slaughter show that silage is not suitable when offered as the sole feed to fatten reindeer calves prior to slaughter (Nilsson, 1994; Nilsson *et al.*, 1996a). However, the studies indicated that silage had advantages during the adaptation period and may serve as one component of the diet. It was concluded that silage with a DM content between 30-50% seemed equally appropriate when fed to 17-month-old male reindeer (Nilsson *et al.*, 1996a). In the third study (Nilsson *et al.*, 1996b) silage based diets with two different proportions of barley were offered to male reindeer calves from September to slaughter in November or March. Calves given the diet with the higher proportion of barley had improved condition during an extended feeding period while the diet containing

the lower proportion of barley seemed insufficient to meet the calves' nutritional needs and was therefore teminated in November. As this, the fourth and final study, was conducted parallel to the last part of the third study (Nilsson *et al.*, 1996b) it seemed appropriate to compare two different proportions of a commercial concentrate mixed with the silage offered to the calves.

Material and methods

Animals, experimental conditions and feeds

A total of 56 male reindeer calves (*Rangifer tarandus tarandus*) about 8-months-old, were taken from a gathering of the Semisjaur-Njarg herd at Stenudden on January 4, 1995. The calves were randomly alloted into five groups. One group of 12 animals was slaughtered at the gathering place on January 4. The remaining four groups, each comprising 11 calves, were taken by truck for about 80 km to the research station in Vuolda, Arjeplog. The station, the pens and the recording of outdoor temperature are as described in Nilsson *et al.* (1996b). The calves spent the first night penned together. On the following day the groups were randomly alloted to the experimental pens and to silage diets with either high proportion, 80%, of concentrate dry matter (DM) and 20% silage DM (HC), or low proportion, 60%, of concentrate DM and 40% silage DM (LC). These four groups of calves were slaughtered on March 23, 1995.

Initially, only about one-third of the pen area was available to the calves but they were given free access to the whole area after 10 days. During the first 12 days of the experiment, lichens (*Cladonia* spp.) were mixed into the feed rations and the amounts of lichens were decreased gradually. On the first day in the experimental pens a total of 0.3 kg DM per animal, of which 0.2 kg DM was lichens, was given to each group. On the second day the reindeer calves were fed twice and the amount of feed was doubled. The following days the feed rations were increased daily by 0.05 kg DM per animal but on the fifth day the rations were increased to 1 kg DM. From that time, the rations again were increased by a maximum of 0.05 kg DM per animal and day until the reindeer had free access to the rations. The amounts of silage and concentrate were adjusted to obtain 5-10% residues.

The silage was made from primary growth of a predominantly meadow-fescue and timothy based sward which also contained minor amounts of red clover. The herbage was harvested in Northern Sweden, wilted and ensiled untreated in plastic-wrapped big bales with eight layers of plastic and stored outdoors. The silage was chopped to about 10 cm lengths with a tractor-powered bale shredder prior feeding. The sampling and the analytical methods are as described by Nilsson *et al.* (1996b). The concentrate used was a commercial pelleted feed (Renfor Hög, Lantmännen, Holmsund, Sweden) based on oat, wheat and their bran products, dried molassed sugar-beet pulp and soya bean meal. The nutrient content of the concentrate refers to the specifications given by the feed manufacturer (Table 1). The concentrate was mixed manually into the silage. The lichens were assumed to contain 7.6 MJ ME and 3% crude protein (CP) per kg DM (Spörndly, 1993). The feeding procedure and the supply of drinking water and mineral lick-stones were as described by Nilsson *et al.* (1996b). The calves were dewormed on January 5 and 16 using ivermectin (Ivomec pour on®, MSD Agvet, USA).

Table 1. Dry matter (DM), crude protein (CP), digestible CP (DCP), ash, water soluble carbohydrates (WSC), neutral detergent fibre (NDF), acid detergent fibre (ADF) and metabolisable energy (ME) content and pH and ammonia-N of total nitrogen (TN) of the silage, as mean ± standard deviation. Nutrient content of the concentrate refers to specifications given by the manufacturer.

	Silage	Concentrate
Number of analyses	7	
DM, %	43.5±1.8	88
CP, g/kg DM	119±7	140
DCP, g/kg DM	81±7	110
Ash, g/kg DM	73±2	-
WSC, g/kg DM*	46±8	-
NDF, g/kg DM*	580±69	-
ADF, g/kg DM*	330±9	-
ME, MJ/kg DM	10.8±0.1	10.2
Ammonia-N, g/kg TN	71±12	-
pH	5.5±0.03	-

* Based on 3 analyses of silage.

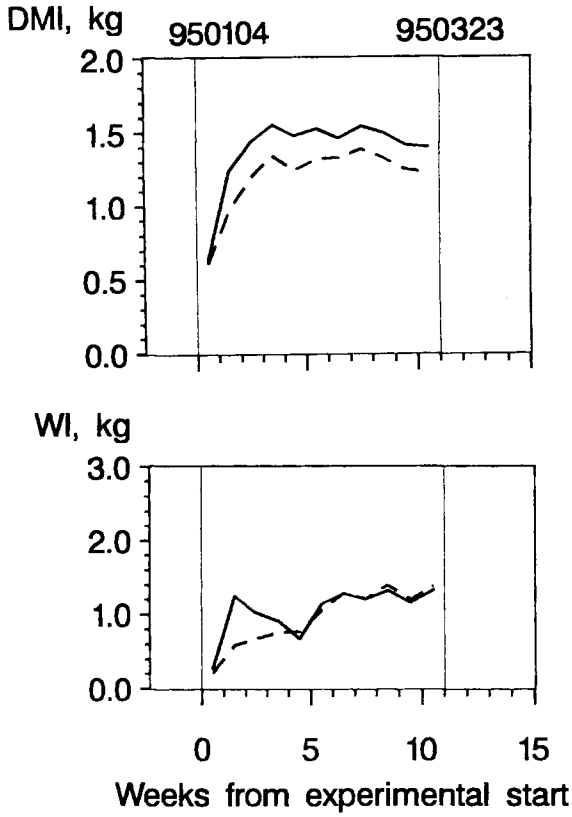

Fig. 1. Weekly means for the daily dry matter intake (DMI) and drinking warer intake (WI) of reindeer calves fed diets with low, 60% (LC, --), or high, 80% (HC, –), proportions of concentrate in the dry matter. The slaughter occasions are indicated by vertical lines.

Live weight and slaughter

The live weight (LW) was recorded as described by Nilsson et al. (1996b). All animals were slaughtered at the reindeer slaughter plant in Stenudden. The calves slaughtered in January waited for about three hours after the gathering. The handling of the calves before slaughter in March and the *post* slaughter procedure used on both occasions was as described by Nilsson *et al.* (1996b).

Statistical methods

All calculations were based on pen means. As there was only a total of two groups per diet in the experiment, the means for each group are presented in the Tables, rather than the treatment means. Student's *t*-test was used to evaluate treatment differences in feed intake and gain in LW. When comparing the results from the different slaughter occasions, the following model, where r_i is the effect of ration (LC and HC-diet), t_j is the effect of slaughter time (January and March) and e_{ijk} is the random error, was applied using the General Linear Models (GLM) procedure described by SAS (1988):

$$Y_{ijk} = \mu + r_i + t_j + e_{ijk}$$

Contrasts were calculated for the effect of initial status compared with status after the feeding period with either of the rations (January *vs.* LC March and January *vs.* HC March) as well as for the effect of ration (LC *vs.* HC). All probabilities greater than 0.05 were denoted not significant (NS).

Results

Nutritional value of the feed

The chemical composition of the silage is presented in Table 1. The average DM content of the silage

Table 2. Number of animals and mean daily inrakes per animal of feed, dry matter (DM), crude protein (CP), metabolisable energy (ME) and drinking water and daily dry marrer (DM) intake per kg live weighr (LW) in groups of reindeer calves fed either a rarion of 60% concentrate and 40% silage (LC) or 80% concentrate and 20% silage (HC).

Ration	LC		HC		Effect of ration
Group number	1	2	3	4	$P\leq$
Number of animals	11	10	11	11	
Feed, kg	1.93	1.97	1.92	1.93	NS
DM,kg	1.19	1.21	1.38	1.39	0.005
DM, g/kg LW	25.5	25.0	30.8	29.8	0.01
CP, g	133	136	152	153	0.007
ME, MJ	12.3	12.6	14.1	14.2	0.006
Water, l	1.13	0.78	1.07	1.04	NS

Table 3. Number of animals, live weight (LW) at start and slaughter and daily live weight gain (LWG) and carcass weight gain (CWG) in groups of reindeer calves (cf. Table 2). Group number 0 was slaughtered at the start of the experiment.

Ration		LC		HC		Effect of ration
Group number	0	1	2	3	4	$P\leq$
Number of animals	12	11	10	11	11	
LW at start, kg	40.6	38.9	40.6	35.6	38.9	
LW at slaughter, kg	40.6	47.4	50.2	48.8	49.1	
LWG, g/day	-	110	122	168	131	NS
CWG, g/day	-	56	68	88	82	NS

was 43.5% and it was of good hygienic and preservative quality. The average DM content of the lichens was 71.8%.

Animal health and behaviour

The animal health during the experiment was good and there were no signs of digestive disturbances or ill health. Nonetheless, one calf from the LC-diet had to be excluded from the experiment on February 7 because of an injured leg.

Feed and water intakes

The mean feed intake is presented in Table 2. The daily DM and water intakes for each week of the experiment is shown in Fig. 1. The daily intake of the HC-diet (1.93 kg) was similar to that of the LC-diet (1.95 kg). The HC-diet resulted in a higher DM ($P<0.01$) and ME ($P<0.01$) intake relative to the LC-diet, 1.39 and 1.20 kg DM and 14.2 and 12.5 MJ ME respectively. There was also a significant ($P<0.01$) difference in the DM intake per kg LW between the HC-diet, 30.2 g, and the LC-diet, 25.3 g.

Water intake, 1.1 litre (HC) and 1.0 litre (LC), was not significantly altered due to dietary treatment. Due to the difference in DM content between the diets the daily water intake via the ingested feed was lower on the HC-diet relative to the LC-diet, 0.55 and 0.75 kg respectively.

Gains in weight and slaughter data

The mean initial LW for all animals in January was 39.0 kg, with a range from 27 to 48 kg. The mean LWs at slaughter in March were 49.0 kg and 48.9 kg on the HC-diet and LC-diet respectively (Table 3). The evolution of LW is shown in Fig. 2. Daily live weight gain (LWG) of calves offered the HC-diet, 152 g, was not significantly different from the LWG on the LC-diet, 116 g.

The dressing percentage in January was 49.5% (Table 4). The dressing percenrages found in March did not differ significantly from those in January or between the HC-diet, 51.1%, and the LC-diet, 50.2%. The daily carcass weight gains (CWG) based on the mean dressing percentage of the calves slaughtered in January, were 85 g and 62 g on the HC and the LC diets, respectively (Table 3).

Reticulo-rumen and its content

For the calves slaughtered in January the weight of the reticulo-rumen content per kg CW was 252 g (Table 4). Less content was found in March on the LC-diet, 187 g, and significantly less ($P<0.05$) on the HC-diet, 141 g. Also the reticulo-rumen tissue was heavier in January, 61 g per kg CW, than in March on the LC-diet, 46 g (not significant) and on the HC-diet, 43 g, ($P<0.05$).

Fat in the abdominal cavity

For the calves slaughtered in March and fed either the HC- or the LC-diet the amount of fat in the abdominal cavity per kg CW was significantly higher (at least $P<0.05$), 17 g and 12 g respectively, compared with the 7.6 g found in January (Table 4). The higher amount of fat on the HC-diet compared with the LC-diet was significant ($P<0.01$).

Liver, kidneys, lungs and heart

The weights of the liver, kidneys, lungs and heart per kg CW are reported in Table 4. The relative weights of the lungs and the kidneys significantly decreased (at least $P<0.05$) from January to March. The weight of the heart or liver per kg CW did not change significantly with time. There were no sig-

Table 4. Slaughter data for groups of reindeer calves (cf. Table 2). Group number 0 was slaughtered at the start of the experiment.

Ration		LC		HC		Contrasts		
Group number	0	1	2	3	4	LC *vs.* HC	Jan. *vs.* LC-Mar.	Jan. *vs.* HC-Mar.
Slaughter time	Jan.	Mar.	Mar.	Mar.	Mar.	$P\leq$	$P\leq$	$P\leq$
Number of animals	12	11	10	11	11			
CW, kg	20.1	23.6	25.5	24.5	25.6	NS	NS	NS
Dressing percentage	49.5	49.8	50.7	50.2	52.0	NS	NS	NS
Content in reticulo-rumen, g/kg CW	252	183	191	154	128	NS	NS	0.02
Tissue of reticulo-rumen, g/kg CW	61.0	49.1	43.5	44.9	41.8	NS	NS	0.05
Kidney-knob, g/kg CW	1.9	6.4	5.4	7.3	8.1	NS	0.03	0.02
Fat in the abdominal cavity, g/kg CW[1]	7.6	12.3	11.2	17.6	16.8	0.01	0.04	0.007
Liver, g/kg CW	26.4	28.7	26.7	29.5	28.3	NS	NS	NS
Kidneys, g/kg CW	6.2	4.8	4.7	5.2	5.0	NS	0.02	0.03
Lungs, g/kg CW	22.6	20.2	20.4	20.0	19.5	NS	0.02	0.01
Heart, g/kg CW	18.1	17.7	18.0	18.1	17.9	NS	NS	NS
pH, M. *longissimus dorsi*	5.90	5.47	5.48	5.50	5.49	NS	0.001	0.001

[1] Fat in the abdominal cavity is the sum of the kidney-knob and the omentum.

nificant differences in the relative weights of the liver, kidneys, lungs or heart between the diets at slaughter in March.

Divergent macroscopical appearances were found in 18 livers, 1 pair of lungs and 1 kidney. Histological examination showed that the injuries were caused by healed parasite attacks.

Carcass assessment

Carcasses from animals offered the HC-diet slaughtered in March had the best grading with a mean grading of O- for conformation and 04 for fat. Calves offered the LC-diet which were slaughtered in March as well as those slaughtered in January had mean gradings of P for conformation and 02 for fat. The ultimate pH-value in *M. longissimus dorsi* was found to be significantly highest in January and with no significant difference between the treatments at slaughter in March (Table 4).

Outdoor temperature

During the experimental period, the outdoor temperature at 10 a.m. varied between 2°C and -22°C. The maximum temperature observed was 8°C and the minimum was -29.5°C. The mean temperature for each week of the experiment was as shown by Nilsson *et al.* (1996b), where the start of the present experiment corresponds to week 18 of that study.

Discussion

The calves started to eat the rations without hesitation. The mixing with lichens during the first two weeks of the feeding period probably facilitated the adaptation by reducing their suspicion of the new diet and possibly also limited ruminal disturbances, as lichen may play an important role in maintaining the integrity of the ruminal microbial system (Aagnes & Mathiesen, 1994). Reindeer calves in poor condition are known to be very sensitive, especially during the period of adaptation to a new feed (e.g. Åhman & Åhman, 1980). Possible markers of body condition of reindeer are the depots of body fat (e.g. Nieminen & Laitinen, 1986) and the content of the reticulo-rumen (Adamczewski *et al.*, 1987). Data from a simultaneous study (Nilsson *et al.*, 1996b), makes it possible to compare the initial condition and the subsequent performance of the free-ranged calves recruited in January 1995 for the present study with calves taken from the same herd in September 1994. Similar amounts of fat in the abdominal cavity 7.2 and 7.6 g per kg CW were found in in September and January, respectively. Of these amounts the kidney-knob constituted 2.6 and 1.9 g per kg CW. Much higher amounts of perirenal fat, corresponding to 5.2 and 4.5 g per kg CW, were reported for female calves from the central part of southern Norway slaughtered in November-December and in January (Ropstad *et al.*, 1991). The lower amounts of fat found in September (Nilsson *et al.*, 1996b) and in January in the present study may indicate a lack of body fat reserves and poorer condition. The mean amount of fat in the abdominal cavity, recorded at the slaughter in March for calves fed the HC-diet, was similar to the amount found for calves slaughtered on the same occasion offered a diet containing 60% barley and 40% silage from September (Nilsson *et al.*, 1996b), while calves fed the LC-diet did not reach the same degree of abdominal fat deposition. The relatively high weight recorded for the content of the reticulo-rumen in January suggests that the calves had access to pasture prior to the gathering in January and thus were not acutely starved (Adamczewski *et al.*, 1987), which might have facilitated adaptation to the feeding. In contrast to the study by Nilsson *et al.* (1996b), where severe health problems occurred five weeks after the start of the feeding, no health problems occurred during the present study. Besides an effect of the substitution of barley to a commercial concentrate as the silage supplement, better developed rumen functions of the older calves in the present study may have affected the adaptation in January.

Among the previous studies in the present series evaluating silage-based diets for reindeer calves (Nilsson, 1994; Nilsson *et al.*, 1996a; 1996b), the highest daily DM intake per kg LW was achieved in the present experiment. Similar DM intakes were observed in the same period of the year for reindeer calves fed an all-concentrate diet *ad lib.* (Ryg & Jacobsen, 1982). The reduction of the DM intake per kg LW observed in the present and the previous studies (Nilsson, 1994; Nilsson *et al* , 1996b), when higher proportions of silage were fed, is in agreement with previous studies (Syrjälä-Qvist & Salonen, 1983).

The major part of the feed residues was silage, and the calves obviously preferred the concentrate to the silage. As the aim of the experiment was to study the voluntary intake of the total diets, the amounts of residues were restricted. If larger amounts of residues had been allowed, the performance had probably been improved by an increased intake of concentrate. In contrast, larger amounts of

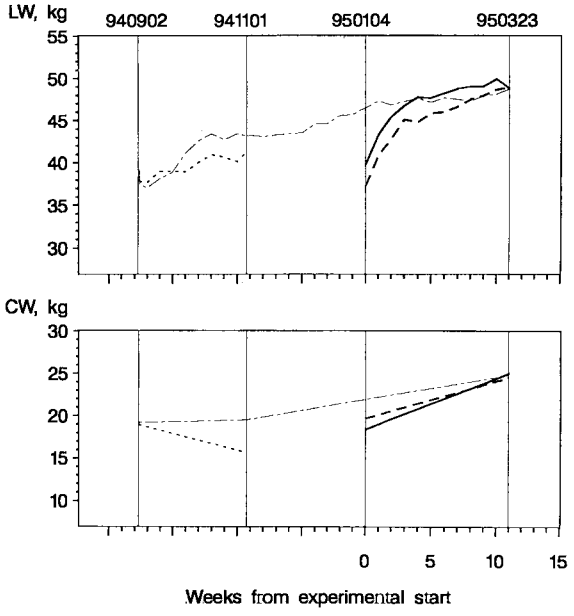

Fig. 2. Evolution of live weight (LW) and carcass weight (CW), respecrively, for reindeer calves fed diets with low, 60% (LC, --), or high, 80% (HC, –), proportions of concentrate in the dry matter. The performance of calves in a parallel experiment (Nilsson et al. 1996b), fed diets with low, 30% (LB, ····), or high, 60% (HB,– ·), proportions of barley in the dry matter are indicated with thin lines. The slaughter occasions are indicated by vertical lines.

residues had impaired the possibility to evaluate the potential feed intake and growth on the specific rations by the selective foraging behaviour of the reindeer. When reindeer calves were given silage and concentrate in two separate cribs, the silage intake was marginal (Nilsson, 1994).

Depending on the type of ration, the animals' degree of adaptation to the diet, and probably also to the season, the quantity of the rumen content varied. The weight of the reticulo-rumen content in the calves slaughtered from natural pasture in January was much greater than that found for calves slaughtered from pasture in September (Nilsson *et al.*, 1996b). However, it corresponds well with findings of Heiskari & Nieminen (1992) for freely grazing calves slaughtered in December. It was also similar to that recorded in November for calves fed a diet containing 40% silage in DM (Nilsson *et al.*, 1996b). The decreased contents in the reticulo-rumen recorded due to increasing the proportion concentrate in the diet is in agreement with the results of Nilsson *et al.* (1996b). Also less digestible material tends to accumulate in the reticulo-rumen when rations of high forage and poor degradability are offered to reindeer, as discussed for hay based rations by Syrjälä-Qvist (1985).

Compared with other studies at the same research station (Nilsson, 1994; Nilsson *et al.*, 1996b) the daily CWG observed in the present experiment were higher on both the LC- and the HC-diets. As shown in Figure 2, calves in the study by Nilsson *et al.* (1996b) and the present one reached the same mean LW and CW at slaughter in March despite quite different feeding periods. It might be stressed that the evolution of LW shown in the figure is based on weekly recordings while the indicated evolution of CW are based on estimates for the slaughter occasions. Thus, the exact patterns of the changes in CW between the slaughter occasions are unknown and it is possible that the slow increase in CW from November actually started later but was steeper. As the calves in the study reported by Nilsson *et al.* (1996b) did not increase their feed intake during the latter part of the experiment the increasing day-length might have influenced the growth patterns for all the calves, as discussed by Suttie *et al.* (1991).

Monitoring of the visceral organs did not reveal any effects of the diets on their relative weights. In a previous (Nilsson *et al.*, 1996b) and the present studies the weight of the visceral organs per kg CW decreased during the feeding period, whereas the absolute weights increased or remained constant. However, in the present study the weight of the liver as a proportion of CW did not change with time. The relative weight of the heart was similar and the relative weights of the liver and kidneys were slightly lower than reported for calves of the same age by Ringberg *et al.* (1981).

The outdoor temperature during the experiment was about 5°C warmer than the average in this area of Sweden (Alexandersson *et al.*, 1991). In combination with the small groups of animals and the large pen areas, this may have predisposed good animal performance. The good performance and the lack of health disturbances in the present study confirm the conclusions from previous studies in the present series that the proportion of silage must be limited and should probably not exceed 40% of the total DM when silage-based diets are fed to reindeer calves. In the present study, the performance was improved when the proportion of silage was reduced to 20% (HC-diet). From a welfare point of view silage as a complement to a concentrate-based diet

may occupy the reindeer in confined areas. The general conclusion from this series of studies on silage-based diets for reindeer intended for slaughter is that the best role of grass silage of this quality is as a limited part of the ration, and that it may play an important role during the adaptation period. Further and more detailed studies concerning digestibility of silage of different qualities are needed to evaluate the applicability of silage as a feed for reindeer.

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References

Aagnes, T. H. & Mathiesen, S. D. 1994. Food and snow intake, body mass and rumen funcrion in reindeer fed lichen and subsequently starved for 4 days. – *Rangifer* 14 (1): 33–37.

Adamczewski, J. Z., Gates, C. C., Hudson, R.J. & Price, M. A. 1987. Seasonal changes in body composition of mature female caribou and calves (*Rangifer tarandus groenlandicus*) on an arctic island with limited winter resources. – *Can. J. Zool.* 65: 1149–1157.

Alexandersson, H. K., Karlström, C. & Larsson-McCann, S. 1991. Temperarure and precipirarion in Sweden 1961–90. Reference normals. – *Meterologi* 81, SMHI, Norrköping, 88 pp.

Heiskari, U. & Nieminen, M. 1992. The effect of the diet on the digestive organ size of reindeer. – *Rangifer* 12 (3): 167–168.

Nieminen, M. & Laitinen, M. 1986. Bone marrow and kidney fat as indicators of condition in reindeer. – *Rangifer* Special Issue No. 1: 219–225.

Nilsson, A. 1994. *Feeding of reindeer during the winter – performance of reindeer calves ifed silage diets and silage-based diets.* – Examensarbete Nr. 60, Sveriges Lantbruksuniversitet. 60 pp. (In Swedish with English Summary).

Nilsson, A., Olsson, I. & Lingvall, P. 1996a. Comparison between grass-silages ofi different dry matter content fed to reindeer during winter. – *Rangifer* 16 (1): 21–30.

Nilsson, A., Olsson, I. & Lingvall, P. 1996b. Evaluation of silage diets fed to reindeer calves intended for slaughter. – I. Feeding of silage and barley from September to March. – *Rangifer* 16 (3): 129–138.

Ringberg, T. M., White, R.G., Holleman, D. F. & Luick, J .R. 1981. Body growth and carcass composirion of lean reindeer (*Rangifer tarandus tarandus* L.) from birth to sexual maturity. – *Can. J. Zool.* 59: 1040–1044.

Ropstad, E., Lenvik, D., Bø, E., Fjellheim, M. M. & Romsås, K. 1991. Ovarian function and pregnancy rates in reindeer calves (*Rangifer tarandus*) in southern Norway. – *Theriogenology* 36: 295–305.

Ryg, M. & Jacobsen, E. 1982. Seasonal changes in growth rate, feed intake, growth hormone, and thyroid hormone in young male reindeer (*Rangifer tarandus tarandus*). – *Can. J. Zool.* 60: 15–23.

SAS 1988. *SAS/STAT User's Guide Release 6.03 Edition.* SAS Institute, Inc., Cary, N.C. 1028 pp.

Spörndly, R. 1993. Fodertabeller för idisslare 1993. – *Speciella skrifter* 52. Sveriges Lantbruksuniversitet, Uppsala (In Swedish).

Suttie, J. M., White, R. G., Breier, B. H. & Gluckman, P. D. 1991. Photoperiod associated changes in insulin-like growrh factor-I in reindeer. – *Endocrinology* 129: 679–682.

Syrjälä-Qvist, L. & Salonen, J. 1983. Effect of protein and energy supply on nitrogen utilization in reindeer. – *Acta Zool. Fenn.* 175: 53–55.

Syrjälä-Qvist, L. 1985. Hay as the feed for reindeer. – *Rangifer* 5 (2): 2–5 (In Swedish with English summary).

Åhman, B & Åhman, G. 1980. *Changing from winter pasture to concentrate feeding of reindeer.* – Report 76 Swedish University of Agricultural Sciences. 65 pp. (In Swedish with English Summary).

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