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# Comparison of grass silage utilization by reindeer and sheep

## 1. Palatability, feeding values and nutrient supply

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**Abstract.** The utilization of silages prepared from grass at three different growth stages was studied with three adult reindeer and three adult sheep. Palatability, digestibility and nitrogen balance trials were performed according to the Latin-square design. As the different silages were similar in chemical composition and quality, the results are mainly expressed and discussed as the averages for all three.

The intake of silage dry matter (DM) by the reindeer averaged 938 g/day and the intake by the sheep 1787 g/day. These values corresponded to intakes of about 3.7 kg and 7.1 kg fresh silage, and 16 g and 27 g DM/kg liveweight, respectively. The total water consumption (water from feed + water drunk) for the reindeer was 5 g/kg DM eaten and for the sheep 3 kg. The digestibility of the different silage constituents was similar in the reindeer and sheep, but the apparent digestibility of crude protein was significantly ($P<0.05$) lower in the reindeer (69 %) than in the sheep (75 %), as were also the other criteria describing the protein utilization. The nitrogen balance was negative in the reindeer, −1.8g/day, but positive in the sheep, +4.7g/day. The criteria of energy utilization were similar in the reindeer and sheep.

It seemed that silage prepared at an early growth stage is a good supplemental feed for reindeer, while for sheep it can be used as the only feed.

### Introduction

Shortage of food during the hard winter months is one of the most serious problems in reindeer husbandry. Attempts have been made to cope with this problem by arranging supplemental or distress feeding, but considerable difficulties have been encountered in the search for suitable feeds and practical feeding techniques. The feeds should be suitable for the reindeer as regards both their composition and nutritive value, besides being economical in price. As to the feeding technique, it has to be feasible in conditions differing widely from those in which domestic animals are fed.

In recent years in Finland much time has been devoted to trials and discussions on the suitability of grass silage as a feed for reindeerc SYRJÄLÄ and HEIKKILÄ 1975, SYRJÄLÄ and VALMARI 1976, 1977, KURKELA 1976,

SYRJÄLÄ 1977, SYRJÄLÄ et al. 1978). In these trials silage has been given alone or together with other feeds, such as grain, lichen or waste fibre from the wood industry, which are poor in protein, but rich in energy. The purpose of the present study was to compare silage utilization between reindeer and sheep. This paper deals mainly with the intake and feeding behaviour, digestibility and nitrogen balance, and nutrient supply in an experiment with animals given silage preserved at three different growth stages. The observations on rumen fermentation and the rumen microbiota in reindeer and sheep are reported in another paper (SYRJÄLÄ-QVIST 1982).

## Experimental procedures

### *The animals and their feeding*

The experimental animals were three adult male reindeer and three adult Finsheep rams. The average liveweight of the reindeer was 58 kg and that of the sheep 66 kg. Before the experiment the animals were kept indoors and fed on silage only for about 6 weeks. The feeding took place twice a day.

A 3×3 Latin-square design was used for both animal groups. Each of the three periods lasted three weeks. During the first 10 days of the period the palatability and feeding behaviour were studied by feeding the animals *ad libitum*. The amount of silage was then restiricted to 85–90 % of the *ad lib.* amounts. The digestibility and N-balance experiments were carried out by the quantitative collection method, applied during the last 7 days of the period. During the experiment the animals were kept in individual cages with a net bottom and a funnel for the collection of urine. Before the beginning of the collection period the animals were provided with faeces-collecting harnesses.

The feeding, sampling, and the treatment and analyses of the samples are explained in more detail by SYRJÄLÄ (1972).

### *Preparation of the silages*

The silages were prepared from the third cutting of the growing season in 1975. Nitrogen fertilizer was applied to the sward at the rates of 70 kg N/ha and in the spring 80 kg N/ha after each of the two first cuttings, altogether 230 kg N/ha. The grass, consisting mainly of cocksfoot (*Dactylis glomerata*), was harvested at three different stages of growth, on 27 August, and 3 and 10 September. The grass was 20–45cm high and no ears were formed by any of the harvesting dates. The grass was chopped and preserved in three glass-fibre silos of 4 $m^3$. AIV II solution (80 % formic acid and 2 % orthophosphoric acid) was used as preservative, being applied as the silo was filled, at the rate of 5 1/1000 kg fresh grass. The pressure was 400 kg/$m^2$.

During the experiment samples were taken from the silages every week for dry matter determinations, and every second week for complete feed analyses.

The silage samples were subjected to the standard feed analyses and analysed for the properties used as criteria of the quality of silage. The methods used are explained in an earlier study (SYRJÄLÄ 1972).

## Results and discussion

### *Chemical composition and quality of silage*

The chemical composition of the dry matter was fairly similar in all the silages (Table 1), the differences being statistically significant in only a few cases ($P < 0.05$).

As the summer was dry, the grass developed rather slowly, which explains why there were only small differences between the different growth stages. At growth stage III some sprouting from the ground was observed, which probably improved the chemical composition of this silage. The presence of new shoots was indicated by the fact that the crude protein content was significantly higher and the crude fibre content significantly lower than in the silages made from grass harvested at the earlier growth stages.

The quality of the silages was good (Table 2). The pH was fairly low in all of them and butyric acid did not occur in any of the samples. The relatively high contents of sugars and low contents of volatile fatty acids and ammonia N showed that fairly little fermentation had occurred.

Table 1. The mean chemical compositon and *in vitro* digestibility of the different silages.

| | Growth stage | | |
|---|---|---|---|
| | I | II | III |
| Dry matter, % | 25.2[a] | 25.2[a] | 24.5[b] |
| % of dry matter: | | | |
| Ash | 11.2[ab] | 11.9[a] | 10.6[b] |
| Organic matter | 88.8[ab] | 88.1[a] | 89.4[b] |
| Crude protein | 14.7[a] | 14.5[a] | 15.9[b] |
| True protein | 9.5[ab] | 9.3[a] | 10.5[b] |
| Crude fat | 5.6 | 5.5 | 5.8 |
| N-free extract | 40.5 | 40.1 | 40.5 |
| Crude fibre | 28.0 | 28.0 | 27.2 |
| Crude carbohydrates | 68.5 | 68.1 | 67.7 |
| *In vitro* digestibility, %: | | | |
| Organic matter | 69.6 | 70.2 | 70.1 |

The Tukey test (STEEL and TORRIE 1960) was used for testing the differences between the averages. Different index letters in a horizontal row show that there are significant differences between the averages at the 95 % level of confidence.

Table 2. Data used as criteria of the quality of the different silages.

| | Growth stage | | |
|---|---|---|---|
| | I | II | III |
| ph | 3.85 | 3.81 | 3.80 |
| % of dry matter: | | | |
| Acetic acid | 1.14 | 1.31 | 1.02 |
| Propionic acid | – | – | – |
| Butyric acid | – | – | – |
| Lactic acid | 7.28 | 7.09 | 9.47 |
| Sugars as glucose | 7.35 | 10.44 | 5.81 |
| Ammonia N | 0.09 | 0.10 | 0.11 |
| % of total N: | | | |
| Ammonia N | 3.8 | 4.4 | 4.2 |
| Soluble N | 51 | 51 | 51 |

*Palatability of silage and water consumption*

The palatability of the silages was fairly good with both the reindeer and the sheep. The intake of silage dry matter by the reindeer averaged 938 g/day (854–1032 g/day), which corresponds to about 3,7 kg fresh silage (Table 3). The corresponding value for the sheep was 1787 g/DM/day (1700–1854 g/day), or 7,1 kg fresh silage a day. The differences between the reindeer and sheep were statistically significant ($P > 0{,}01$ or $> 0{,}001$).

The reindeer consumed about 16 g DM/kg liveweight, which was the same amount (SYRJÄLÄ and HEIKKILÄ 1975), or higher than in other experiments ( SYRJÄLÄ and VALMARI 1976, 1977). The intake of dry matter by the sheep averaged 27 g/kg liveweight, which is about the usual consumption value for sheep (SYRJÄLÄ 1972, 1975).

The reindeer found the silage prepared at growth stage I the most palatable, but the sheep liked best that prepared at growth stage III. The intake of silage by sheep has been found to depend on the fermentation level of the silage (SAUE 1968, SYRJÄLÄ 1975). This was also the case with reindeer in an experiment where different silages were compared (SYRJÄLÄ and VALMARI 1977); an increase in the amount of fermentation products decreased the intake of silage.

Table 3. Silage intake, g/animal/day.

| | Reindeer | Sheep | Significance |
|---|---|---|---|
| Growth stage I | 3965 | 7068 | xx |
| " " II | 3371 | 6760 | xxx |
| " " III | 3727 | 7406 | xx |
| Average | 3688 | 7078 | |

xxx $P<0.001$
xx $P<0.01$

In the present experiment this effect was not clear, because the fermentation of the silages was at the same level, as is shown by the quality criteria (Table 2).

The silage intake differed fairly greatly between the individual reindeer and sheep. The reindeer also showed individual differences in becoming accustomed to eating silage. The feeding habits differed between the reindeer and sheep. The sheep rapidly ate up their whole ration, but the reindeer ate it slowly, taking the whole day for it and ruminating between.

The water intake was measured every day during the experiment. The average total water consumption was as follows:

| | Reinder | Sheep |
|---|---|---|
| Water, drunk, g/day | 2347 | 793 |
| " received with feed, g/day | 2157 | 4326 |
| Total water consumption, g/day | 4504 | 5119 |
| Water consumption, kg/kg DM eaten | 5 | 3 |

The reindeer drank three times more water than sheep, but the sheep received more water in the silage. The amount of water drunk varied greatly between the animals. With the reindeer it ranged from 1356 to 2781 g/day and with the sheep from 36 to 2106 g/day. However, the water drunk did not differ with the silages.

*Digestibility, N balance and other feeding values of silage*

As the silages were fairly similar in respect of their quality, composition and *in vitro* digestibility, the *in vivo* digestibility coefficients are expressed as the average values for all the silages. This has also been done because no results were available for one reindeer concerning growth stage I, owing to the death of the animal. Thus each value in Table 4 is the average of 8 trials with reindeer and 9 trials with sheep.

The digestibility of the different silage constituents was fairly good and similar in the reindeer and the sheep, but the apparent digestibility of crude protein was significantly ($P<0.05$) lower in the reindeer. The other criteria of protein utilization (N balance, biological value of protein, etc) were also significantly lower in the reindeer than in the sheep. The criteria of energy utilization, however, were similar in the reindeer and sheep.

ERIKSON and SCHMEKEL (1962) found no great variation between reindeer and sheep in their ability to digest different rations. The digestibility of hay for reindeer has been found to be as good as for the dairy cow (NORDFELT et al. 1961). The negative N balance obtained here has been noted in some earlier silage-based experiments, but in other experiments with reindeer on silage-based feeding it has also been positive (SYRJÄLÄ and HEIKKILÄ 1975, SYRJÄLÄ and VALMARI 1976, 1977, SYRJÄLÄ et al. 1978).

*Energy and protein supply on silage feeding*

On the *ad libitium* feeding the reindeer consumed on the average 3.7 kg silage and thus received 0.69 f.u. and 98 g DCP (see Table 4). The sheep consumed

Table 4. Digestibility, N balance and feeding values of silage.

| | Reindeer | Sheep | Significance |
|---|---|---|---|
| Digestibility | | | |
| Dry matter | 69 | 71 | |
| Organic matter | 73 | 73 | |
| Crude protein | 69 | 75 | xx |
| Crude fat | 62 | 59 | |
| N-free extract | 77 | 75 | |
| Crude fibre | 72 | 73 | |
| Crude carbohydrates | 75 | 74 | |
| N balance, g/day | −1.8 | +4.7 | xx |
| Biological value [1] | 32 | 45 | x |
| kg/f.u. [2] | 5.2 | 5.2 | |
| DM kg/f.u. [3] | 1.35 | 1.35 | |
| DCP g/f.u. [4] | 141 | 154 | xx |
| DCP % in DM | 10.5 | 11.4 | x |

xx $P<0.01$
x $P<0.05$

1) Estimated with the formula of Mitchell (MAYNARD and LOOSLI 1962).
2) f.u. = feed unit = 0.7 starch equivalent
3) DM = dry matter
4) DCP = digestible crude protein

7.1 kg silage, the corresponding energy supply being 1.32 f.u. and the protein supply 204 g DCP.

The daily energy requirement of adult male reindeer for maintenance during the winter has been evaluated at 2 f.u./100 kg liveweight and that of protein at 110 g DCP/100 kg liveweight (PERSSON 1969). The corresponding values in this experiment should be 1.2 f.u./day and 64 g DCP/day.

The amounts of silage consumed by the reindeer could thus be expected to give an energy deficit of 0.5 f.u. Account must however, be taken of the fact that the reindeer were kept caged indoors at a temperature of +12 – +13°C, and did not spend so much energy for heat formation, moving and looking for food. As the weight of the animals remained fairly constant throughout the experiment, it seems probable that in these experimental conditions their energy requirement was satisfied by about 0.7 f.u./day.

During the hard winter months the energy requirements of reindeer living free in nature can be nearly twice as much as the energy needed for maintenance alone. The intake of silage necessary to meet the energy requirement of free-living reindeer, and also pregnant or suckling reindeer, would be at least 7–9 kg/day, which might be too large an amount.

With the silage consumption the protein requirement for maintenance was exceeded by about 53 %. But this amount of silage might be too low to satisfy the protein requirement of female reindeer when they are pregnant or suckling.

The energy the sheep received with silage in this experiment is sufficient for maintenance and also for ewes during pregnancy, but not for suckling

more than one lamb (SYRJÄLÄ 1976). The protein of this silage is also sufficient at all production levels, except when the ewe has to suckle three or more lambs.

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# Säilörehun hyväksikäytön vertailu porolla ja lampaalla. 1. Maittavuus, rehuarvo ja ravinteiden saanti

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Kolmella eri kehitysasteella olevasta nurmesta valmistettujen säilörehujen hyväksikäyttöä selvitettiin täysikasvuisilla poroilla ja lampailla tehdyillä maittavuus-, sulavuus- ja typpitasekokeilla. Kokeet järjestettiin 3×3 Latinalaisten neliöiden mukaan. Koska eri säilörehut olivat koostumukseltaan ja laadultaan lähes samanlaisia, on tulokset esitetty ja tarkasteltu pääasiassa niiden keskiarvoina.

Säilörehun kuiva-aineen syönti oli porolla keskimäärin 938 g/pv ja lampaalla 1787 g/pv. Luvut vastasivat porolla 3.7 kg ja lampaalla 7.1 kg tuoretta säilörehua sekä 16 g ja 27 g kuiva-ainetta/elopainokilo. Veden kokonaiskulutus (rehun mukana saatu + juotu vesi) oli porolla 5 kg ja lampaalla 3 kg syötyä kuiva-ainekiloa kohti.

Säilörehun eri aineosien sulavuus oli samaa luokkaa molemmilla eläimillä. Vain raakavalkuaisen sulavuus oli porolla (69%) merkitsevästi ($P<0.05$) alempi kuin lampaalla (75 %). Myös muut valkuaisen hyväksikäyttöä kuvaavat kriteerit olivat porolla alhaisemmat kuin lampaalla. Typpitase oli porolla negatiivinen, −1.8 g/pv, mutta lampaalla positiivinen, +4.7 g/pv. Energian hyväksikäyttöä kuvaavat kriteerit sensijaan olivat samanlaiset molemmilla eläimillä.

Näyttäisi siltä, että suhteellisen nuorella kehitysasteella valmistettu säilörehu on käyttökelpoinen lisärehu porolle, kun taas lampaalle se käy ainoaksi rehuksi.