

Dissertations

Tove Hilde Aagnes Utsi successfully defended her Doctor Scient. thesis "*Digestive strategies in reindeer in winter*" at the University of Tromsø, Norway 16th May 1998.



Tove Hilde Aagnes Utsi is from Gildeskål municipality in Nordland county, Norway and was educated at the Department of Arctic Biology, Institute of Medical Biology, University of Tromsø. She was Cand. Scient. in 1990 with a thesis entitled "*Bacterial fermentation of lichen and ruminal responses to starvation in Norwegian reindeer*". Aagnes Utsi continued with a scholarship for the period 1991-1994 studying ruminal responses to a natural winter pasture in reindeer and grass silage as emergency food for reindeer. The study has been in close collaboration with the Norwegian Crop Research Institute, Holt Research Centre, Tromsø and Norwegian College of Veterinary Medicine, Department of Arctic Veterinary Medicine, Tromsø. She has from 1995 had a position at the Norwegian Reindeer Husbandry Administration in Alta.

Her thesis is based on the following five papers:

- I. Aagnes, T. H. & Mathiesen, S. D. 1994. Food and snow intake, body mass and rumen function in reindeer fed lichen and subsequently starved for 4 days. – *Rangifer* 14: 33–37.
- II. Aagnes, T. H., Sørmo, W. & Mathiesen, S. D. 1995. Ruminal microbial digestion in free-living, in captive lichen-fed and in starved reindeer (*Rangifer tarandus tarandus*) in winter. – *Appl. Environ. Microbiol.* 61: 583–591.
- III. Aagnes, T. H., Blix, A. S. & Mathiesen, S. D. 1996. Food intake, digestibility and rumen fermentation in reindeer fed baled timothy silage in summer and winter. – *J. Agric. Sci., Camb.* 127: 517–523.
- IV. Olsen, M. A., Aagnes, T. H. & Mathiesen, S. D. 1997. The effect of timothy silage on the rumen bacterial population in rumen fluid of reindeer (*Rangifer tarandus tarandus*) from natural summer and winter pasture. – *FEMS Microbiol. Ecol.* 24: 127–136.

- V. Aagnes, T. H. & Mathiesen S. D. 1996. Gross anatomy of the gastrointestinal tract in reindeer, free-living and fed baled timothy silage in summer and winter. – *Rangifer* 16: 31–39.

Summary: Deep snow and overicing in the sub-Arctic areas in winter can result in restricted pasture availability or acute starvation for the reindeer. In such situations provision of emergency food may be necessary to prevent loss of animals. Emergency food for free-living reindeer needs to have high acceptability and should not cause any digestive disorders, even in animals starved for some days. In addition, it should preferentially meet the animals maintenance energy requirements. To find such food, basic knowledge of the digestive processes in reindeer were needed and made basis for this study.

To investigate if reindeer had special adaptation to maintain the rumen function when exposed to acute starvation, rumen fluid volume and fluid turnover time were measured in reindeer fed pure lichen and after four days of starvation, by using a liquid-phase chromium-EDTA marker (paper I). In lichen fed reindeer rumen fluid volume and turnover time varied considerably between animals (volume range 3.8-10.8 l; turnover range 22.5-69.0 h), but were fairly constant in individual animals. These values did not change significantly in response to starvation, mainly due to a conspicuously increased snow intake. This fact naturally reduced reticulo-rumen dry matter and microbial population, which in turn will reduce the ability of the animal to digest plant material after starvation.

In free-living reindeer from northern Norway, eating a mixed winter diet dominated by lichens, the rumen fermentation, bacterial population density and composition were studied, and compared with reindeer fed pure lichen and subsequently starved for four days (paper II). Bacterial population densities in the rumen fluid and associated to the plant particles were recorded, using the dilution method and habitat stimulating growth medium, both in lichen fed and free-living reindeer ranging between $15.0-500.0 \times 10^8$ bacteria per ml rumen fluid and per gram rumen solids. The bacterial population density associated to the plant particles was significantly higher in the free-living reindeer than in the lichen fed. The bacterial composition in the free-living reindeer seems to be adapted to a fibre digestion, which could not be found in the lichen fed animals. Total ruminal volatile fatty acid concentrations ranged between 57.4-72.1 mM in the lichen fed reindeer compared to 70.4-82.6 mM in the free-living reindeer. Starvation for 4 days reduced the rumen bacterial population densities both in the rumen fluid and associated to the plant particles more than 90%, the bacterial composition changed, ruminal pH increased and ruminal volatile fatty acid concentration decreased considerably. The study indicates that intake of a natural mixed winter diet improve the growth condition of the

rumen bacteria and microbial digestion in reindeer compared with a pure lichen diet. When the reindeer are exposed to acute starvation, the ruminal microbial environment changes considerably.

To understand the ability of reindeer to adapt to a grass diet in winter, food intake, digestion, ruminal fermentation and bacterial population, gastrointestinal anatomy and body condition have been investigated in reindeer taken from a natural winter pasture and fed different round baled grass silage qualities. (paper III, IV, & V).

Well preserved qualities of grass silage, independent of maturity of the plants have been shown to be highly acceptable to reindeer. The silage structure and chemical composition however, seem to influence the gastrointestinal tract anatomy substantially and hence, the utilisation of the silages. Reindeer easily adapted to high-quality

timothy silage with 89% leaves, 38.7% dry matter cell wall content and 30.0% dry matter water soluble carbohydrates content. Both summer and winter the digestible energy intake was high (range 13.9-17.2 MJ/d), reticulo-rumen digesta load small (range 9.6-18.3% of body mass) and carcass weight high (range 45.8-52.6% of body mass). In reindeer fed fibrous timothy silage with 27% leaves, 57.8% dry matter cell wall content and 6.2% dry matter water soluble carbohydrates content the digestible energy intake was low (range 8.3-9. MJ/d), reticulo-rumen digesta load was great (range 25.1-33.3% of body mass) and carcass weight was low (range 34.3-42.2% of body mass). This indicates that reindeer have limitations in utilising roughage with high fibre content.

Thus, high-quality leaf rich timothy silage seems to be a diet suitable as emergency food for reindeer.