

# Transfer of radiocaesium from lichen to reindeer

**Birgitta Åhman,**

Department of Clinical Nutrition, Swedish University of Agricultural Sciences, Uppsala, Sweden.

## Introduction

After the Chernobyl accident in april 1986 a large part of the reindeer hearing area in Sweden was contaminated with radioactive caesium ( $^{134}\text{Cs}$  and  $^{137}\text{Cs}$ ). Lichens - the main winter forage for reindeer - were heavily contaminated. Large intake of lichens in the winter results in high activity concentrations of radiocaesium in reindeer in contaminated areas.

Activity concentrations of  $^{137}\text{Cs}$  in reindeer meat from five saami villages has been compared to the levels in lichens and to the deposit of  $^{137}\text{Cs}$  per  $\text{m}^2$  ground surface in these saami villages (Table 1). The amount of  $^{137}\text{Cs}$  in reindeer meat (Bq/kg) in the first winter after the Chernobyl accident was approximately at the same level as the amount in dry lichens (Bq/kg dry weight) in June-October 1986 (from Eriks-

son et al, 1987) an within the range of the deposit per  $\text{m}^2$  (from map by SGAB, 1986).

During the late sixties, after the nuclear weapons tests, caribou in Alaska had levels of radiocaesium in muscle about one third of the levels in dry lichens (Luick, 1974). Lidén and Gustafsson (1967) reported levels of  $^{137}\text{Cs}$  in reindeer meat in the years 1961-65 to be about 50 % of the content of  $^{137}\text{Cs}$  in one  $\text{m}^2$  of lichen carpet.

Factors that influence the biological halflife of radiocaesium in reindeer, e.g. total food intake, metabolic activity and amount of potassium and fibre in the diet, should also affect the level of radiocaesium in the body at a given daily intake. The amount of lichens in the diet will thus be an important factor, since lichens contain only small amounts of potassium and protein. Jones et al. (1989) has calculated fractional

Table 1. Radiocaesium fallout ( $\text{kBq } ^{137}\text{Cs}/\text{m}^2$ ), activity concentration of  $^{137}\text{Cs}$  in lichens, *Cladina arbuscula*, ( $\text{kBq}/\text{kg}$  d.w.) and in reindeer meat ( $\text{kBq}/\text{kg}$ ) from five saami villages.

Sami village	$\text{kBq}/\text{m}^2$ May-Och 1986*	$\text{kBq}/\text{kg}$ d.w. in lichens ( <i>Cladina</i> <i>arbuscula</i> ) June-Oct 1986**	$\text{kBq}/\text{kg}$ in reindeer meat Dec 1986-Feb 1987		
			mean	range	no of animals
Sörkaitum	0- 2	1.1	0.7	(0.3- 1.6)	n = 453
Tåssåsen	2- 3	1.1, 1.9, 2.0, 2.3	1.5	(0.7- 2.1)	n = 19
Mittådalen	2- 5	2.2, 6.1	3.0	(1.3- 6.5)	n = 212
Gran	5-20	7.1, 8.8, 10.0	11.5	(3.7-18.5)	n = 113
Vilhelmina norra	20-60	15, 26, 39, 44	26.6	(14.5-56.3)	n = 156

\*SGAB 1986 \*\*Eriksson et al. 1987

transfer from grazing plants to meat (Bq/kg in meat relative to intake, Bq/day). The values were 0.65 d/kg in February, when the lichen intake was about 65 % of the total diet, and 0.24 - 0.36 d/kg in July - September, when lichen intake was 17 % or less.

## Material and methods

To test the influence of relative intake of lichens on transfer of radiocaesium from lichen to reindeer, a feeding experiment with six one year old male reindeer was performed in April - May 1989. The animals were fed different amounts of lichens; 73 %, 40 % or 12 % of lichen d.m. in the feed respectively (two animals on each treatment). By using lichens with different activity concentrations of  $^{137}\text{Cs}$  the daily intake could be kept at the same level, 1.8 kBq/day, for all animals. In combination with lichens the animals were fed pelleted reindeer feed and some hay. The total dry matter intake was 1500 g/day.

During the experiment the level of radiocaesium in the bodies of the reindeer was evaluated

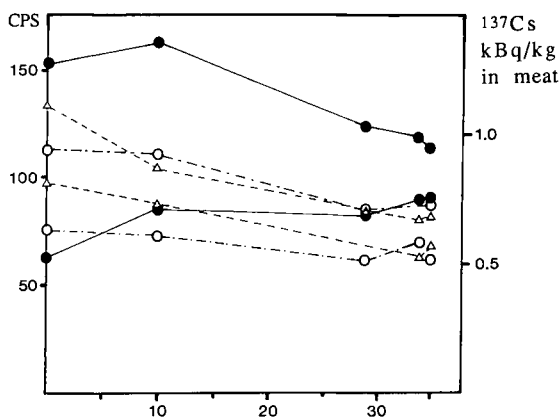


Figure 1. External radiation from live reindeer during the experiment and activity concentrations of  $^{137}\text{Cs}$  at slaughter. The reindeer were fed 73 % (●), 40 % (○) and (△) of lichens respectively. All reindeer received 1.8 kBq of  $^{137}\text{Cs}$ /day.

by measuring external radiation, using a gamma detector (GRS-500) (Åhman 1988). After 35 days the animals were slaughtered and the activity concentration of  $^{137}\text{Cs}$  in muscle was measured.

## Results

During the 35 days of feeding the body weights of the animals increased with 5 kg at an average (from 46 kg at an average at the start of the experiment).

The two reindeer receiving 73 % of lichens in their diet reached activity concentrations of  $^{137}\text{Cs}$  in muscle about 0.5 times the daily intake of  $^{137}\text{Cs}$  (Figure 1). This relation was somewhat lower, 0.35 at an average, for reindeer receiving 40 % or 12 % of lichens in their diet.

## References

- Eriksson, O., Johansson, L., Wickman, M. & Nylen, T. 1987. Radioaktivt cesium i renbetet. Provtagnningar 1986-06-02 - 1986-10-30. - *Meddelande från Växtbiologiska institutionen*, Uppsala. 1987:2. 20 pp.
- Jones, B. E. V., Eriksson, O. & Nordkvist, M. 1989. Radiocaesium in reindeer on natural pasture. - *The Science of the Total Environment*, 85:207 - 212.
- Lidén, K. & Gustafsson, M. 1976. Relationships and seasonal variation of  $^{137}\text{Cs}$  in lichen, reindeer and man in northern Sweden 1961-1965. - In: Åberg, B. & Hungate, F. P., eds., *Radioecological concentration processes*. Oxford, pp. 193-208.
- Luick, J. R. 1974. Nutrition and metabolism in reindeer and caribou in Alaska. - *Progress report U.S.A.-E.C. Contract AT(45-1)-2229, July 1973 - December 1974*, Institute of Arctic Biology, University of Alaska, Fairbanks Alaska. 109 pp.
- SGAB, 1986. Cesium-137 markbeläggning över Sverige. (Cesium-137 kBq/m<sup>2</sup> ground surface). Map based on areal surveys May - Oct 1986. - *Swedish Geological CO*, Uppsala, Sweden.
- Åhman, G. 1988. The association between caesium in reindeer meat and external radiation from live reindeer. - *Report from Dept. of Animal Nutrition and Husbandry, Swedish University of Agricultural Sciences*, Uppsala, Sweden. 5 pp.