

## A TEST OF THE USEFULNESS OF A COMMERCIALY AVAILABLE MILL «WASTE PRODUCT» (AB-84) AS FEED FOR STARVING REINDEER

En test på anvendeligheten av kornavrens (AB-84) som fôr til utsultet rein.

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MATHIESEN, S. D., ROGNMO, A. & BLIX, A. S. 1984. A test of the usefulness of a commercially available mill «waste product» (AB-84) as feed for starving reindeer.

*Abstract:* 3 Norwegian reindeer were first fed lichen ad libitum for 40 days, then they were starved for 3 days, and thereafter offered a commercially available mill «waste product» (AB-84) ad libitum. One animal refused to eat AB-84 and was excluded. When eating lichen average daily dry matter intake was  $1.1 \pm 0.4$  kg, while when eating AB-84 after the starvation period it averaged 1.1 kg at day 1, increasing to 2.5 kg at day 7. After 12 days daily dry matter intake varied between 2 and 4 kg. The rumen dry matter percentage was 16 when eating lichen, 6 after 2 days of starvation, and 17 after eating AB-84 for 5 days. Ruminal pH was  $6.4 \pm 0.3$  when eating lichen, increasing to 7.4 after 3 days of starvation and dropping to an all time low of 6.1, 12 hours after refeeding. The viable bacterial count was  $4.7 \times 10^{10} \pm 2.7$ ,  $5.5 \times 10^8 \pm 2.0$  and  $3.1 \times 10^{10} \pm 1.7$ /ml rumen fluid when the animals were eating lichen, had starved for 3 days and had been eating AB-84 for 5 days, respectively. The rumen ciliate protozoa numbered  $17.1 \times 10^5 \pm 2.7$ /ml rumen fluid, when eating lichen, dropping to  $4.3 \times 10^5 \pm 0.6$ /ml after 3 days of starvation. A further drop to  $1.8 \times 10^5 \pm 0.5$ /ml was observed 1 day after refeeding, but the rumen ciliate number was normalized at  $15 \times 10^5 \pm 1$ /ml already 8 days after refeeding. These results indicate that the mill «waste product» (AB-84) is very well tolerated even by reindeer suffering from starvation. Since it is moreover commercially available at a favourable price it could be of interest to reindeer herders. In any case, it deserves to be tested under controlled conditions on a larger number of animals.

Key words: Rangifer, starvation, rumen microbes.

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MATHIESEN, S. D., ROGNMO, A. & BLIX, A. S. 1984. En test på anvendeligheten av kornavrens (AB-84) som fôr til utsultet rein.

*Sammendrag:* 3 norske rein ble gitt lav ad libitum i 40 dager, sultet i 3 dager og deretter gitt kornavrens (AB-84) ad libitum. Ett av dyrene nektet å spise AB-84 og ble satt ut av forsøket. Daglig fôrøpptak i kg tørrstoff var gjennomsnittlig  $1.1 \pm 0.4$  kg under lavfôring, mens opptaket av AB-84 var gjennomsnittlig 1.1 kg/dag den første dagen etter sulteperioden. Den syvende dagen var opptaket 2.5 kg/dag, og varierte mellom 2 og 4 kg/dag etter 12 dager. Prosent tørrstoff i vominnholdet var 16 under lavfôring, 6 etter 2 dagers sult og 17 etter 5 dagers fôring med AB-84. pH i vominnholdet ble målt til gjennomsnittlig  $6.4 \pm 0.3$  under lavfôring, 7.4 etter 3 dagers sult og falt bare til 6.1, som lavest målte verdi, etter 12 timers ad lib. tilgang på AB-84. Antall levende bakterier pr. ml vomsaft var henholdsvis  $4.7 \times 10^{10} \pm 2.7$ ,  $5.5 \times 10^8 \pm 2.0$  og  $3.1 \times 10^{10} \pm 1.7$  når dyrene spiste lav, hadde sultet i tre dager og hadde spist AB-84 ad lib. i fem dager. Antall eiliater var  $17.1 \times 10^5 \pm 2.7$  pr. ml vomsaft når dyrene spiste lav og  $4.3 \times 10^5 \pm 0.6$  etter tre dagers sult. Etter en dags ad lib. tilgang på AB-84 var antallet  $1.8 \times 10^5 \pm 0.5$  pr. ml og etter fem dager  $7.7 \times 10^5 \pm 1.8$ /ml. Disse resultatene indikerer at selv sultet rein tolererer kornavrens (AB-84) meget godt, og da fôret er kommersielt tilgjengelig til en rimelig pris, kan det være av interesse for reindriftsutøvere. I alle tilfeller fortjener fôret å bli utprøvet på et større antall dyr under kontrollerte betingelser.

*Rangifer* 4 (1): 28 - 34

MATHIESEN, S. D., ROGNMO, A. & BLIX, A. S. 1984. Koe viljaperkeen (AB-84) käyttökelpoisuudesta rehuna nälkiintyneelle porolle.

*Yhteenveto:* Kolmea norjalaista poroa ruokittiin jäkälällä ad libitum 40 päivää, annettiin nähdä nälkää 3 päivää ja sen jälkeen ruokittiin taas viljaperkeellä (AB-84) ad libitum. Yksi eläimistä kieltäytyi syömästä AB-84 ja näin ollen jouduttiin poistamaan kokeilusta. Päivittäinen rehutarve kuiva-ainekilossa oli keskimäärin  $1.1 \pm 0.4$  kg jäkäläruokinnassa, kun taas AB-84 ruokinta oli keskimäärin  $1.1$  kg/päivässä ensimmäisenä päivänä nälkäkauden jälkeen. Seitsemäntenä rehunkulunki oli  $2.5$  kg päivässä, vaihdellen  $2-4$  kg päivässä 12 päivän jälkeen. Kuiva-ainesprosentti pötsinsisällössä oli 16 jäkäläruokinnassa, 6 kahden päivän nälän jälkeen ja 17 viisipäiväisen AB-84 ruokinnan jälkeen. Pötsinsisällön happamuus, pH mitattiin keskimäärin  $6.4 \pm 0.3$  jäkäläruokinnassa,  $7.4$  kolmipäiväisen nälän jälkeen ja väheni vain  $6.1$ :een, joka on alhaisin mitattu arvo, 12 tunnin AB-84 ruokinnan ad lib. jälkeen. Elävien bakteerien lukumäärä pötsinestemillilitraa kohti oli kyseelliset  $4.7 \times 10^{10} \pm 2.7$ ,  $5.5 \times 10^8 \pm 2.0$ , ja  $3.1 \times 10^{10} \pm 1.7$  kun eläimet söivät jäkälää, olivat nälkiintyneet 3 päivää ja syöneet AB-84 ad lib. viisi päivää. Ciliamäärä oli  $17.1 \times 10^5 \pm 2.7$  pötsinestemillilitraa kohti eläinten syötyä jäkälää ja  $4.3 \times 10^5 \pm 0.6$  kolmipäiväisen nälkiintymisen jälkeen. Yhden päivän AB-84 ruokinnan ad lib. jälkeen määrä oli  $1.8 \times 10^5 \pm 0.5$  millilitralta ja viiden päivän jälkeen  $7.7 \times 10^5 \pm 1.8$  millilitralta.

Nämä tulokset osoittavat, että jopa nälkiintynyt poro sietää viljaperkettä (AB-84) erittäin hyvin, ja koska rehua on saatavana kohtuulliseen hintaan se voinee kiinnostaa poromiehiä. Joka tapauksessa rehua kannattaa kokeilla tarkkailtuin edellytyksin suuremmalle eläinryhmälle.

*Rangifer* 4 (1): 28 - 34

## INTRODUCTION

In Scandinavia reindeer are often prohibited from access to food when snow and ice cover the range. It follows that the animals will suffer from starvation under such circumstances. The natural winter diet of reindeer primarily consists of lichen, and some reindeer herders are known to use lichen, harvested in the fall, as a feed supplement for reindeer during winter. Lichen has, however, high water content and is difficult to keep, unless it is frozen, and it is costly to obtain in adequate amounts. In attempts to satisfy the frequent demands for a commercially available feed which can be offered ad libitum to starving reindeer different concentrates have been tested. More often than not, however, starving reindeer suffer from digestive disturbances, or even die, when offered concentrates, unless they are gradually adapted to the feed.

This is at least in part due to the fact that most concentrates have a high content of easily soluble protein and carbohydrates. In reindeer not adapted to such a diet this produces an abrupt increase in ruminal fermentation rate which results in a lowering of rumen pH. This in turn favours the growth of lactate producing bacteria further depressing rumen pH. Ruminal acidosis depresses other microbes necessary for adequate digestion of this diet and also inhibits the motoric activity of the entire alimentary system. This results in the passage of undigested protein and carbohydrates from the rumen into the small intestine - ultimately leading to enteritis and death. It follows that

starved reindeer should be offered a diet high in fibre and low in soluble protein and carbohydrates to avoid an uncontrolled increase in rumen fermentation rate. A commercially available mill «waste product» (Table 1) seems to satisfy these demands. Moreover, in a pilot experiment we did not detect any appreciable ruminal acidosis or signs of indigestion when an animal fed only lichen for one month was offered this feed ad libitum after four days of complete starvation. Encouraged by this result we have presently investigated its effects on ruminal pH and microbial activity in starved reindeer in more detail.

## MATERIAL AND METHODS

Two 4 - 5 years old females and one 2 years old male Norwegian reindeer (*Rangifer tarandus tarandus*) obtained from a local herd outside Tromsø in early winter were used in this study. All three animals were surgically equipped with permanent rumen fistula (Hecker 1974). The two females had no previous experience with artificial feed while the male had. The latter was therefore innoculated with rumen fluid from the other two. All animals were kept in private outdoor pens and offered lichen and snow only for a period of 40 days after the fistulation, and then starved completely for 3 days. After this ordeal they were offered a fine-grained and pelleted ( $\varnothing = 9$  mm) mill «waste product» (AB-84) ad libitum. Feeding always took place at 0900 h. The composition of this feed is given in (Table I). It should be noted that mill «waste products» may differ in its

composition, and that the results of this report only relate to the composition given in Table I. The main components of the feed are waste from the grain mills: small bits of straw from oats and barley, weeds, seeds of weeds, shaffs from oats and barley. Potato starch was used as a binding agent in the pelleting process. The feed is commercially available at about half the cost of RF-71 (Jacobsen and Skjenneberg 1976), but feed intake is normally greater when the animals are offered AB-84 ad lib. Thus, maintenance cost could run at about the same level. The food intake of each animal was measured daily and dry matter intake determined. Body weight was recorded at weekly intervals until the start of the starvation period, whereafter it was recorded every day.

Ruminal pH was measured at 0900, 1200, 1500 and/or 2000 h. using a Radiometer® GK 230 IC Electrode connected to a Radiometer® pH meter model 26. The electrode was introduced through the fistula and immersed in the rumen content for at least 3 min before any reading was recorded.

200 ml of rumen content was collected anaerobically through the fistula by use of a rumen pipette, at intervals, always at 0900 h. 50 ml of the rumen content was dried for determination of its dry matter percentage. The rest of the samples was strained through two layers of muslin, and the rumen fluid thereby obtained was used for determination of ruminal ciliate and viable bacterial numbers.

For the estimation of the total number of rumen ciliates 10 ml of rumen fluid was fixed in 3% glutaraldehyde. The samples were diluted in a phosphate buffer and the number of ciliates determined in 50 µl pools on a plancton counting chamber under a light microscope (Imai and Otimoto, 1981, G. S. Coleman Pers. Comm.).

The number of viable bacteria pr. ml rumen fluid was determined after dilution and cultivation for 48 h in Hungate anaerobic tubes containing a general nonselective carbohydrate medium as substrate. The medium was prerduced by cystein, and rezauserin was used as an anaerobic indicator (Orpin, 1982).

## RESULTS

One of the animals, a very nervous female, refused to eat the mill «waste product» (AB-84) when it was offered after the starvation period, and was therefore excluded.

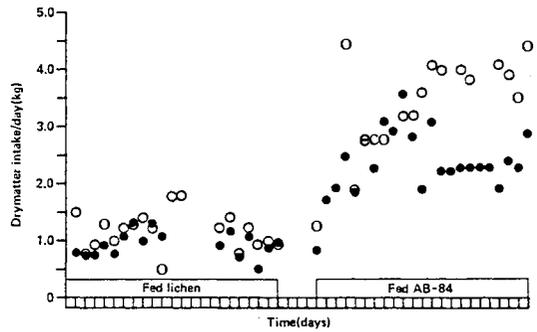


Fig. 1. Dry matter intake in one male (○) and one female (●) Norwegian reindeer offered first lichen ad lib., and then after a 3-day starvation period, a mill «waste product» (AB-84) ad lib..

Fig. 1. Torrstoff inntak pr. dag pr. dyr i form av lav (lichen) og kornavrens (AB-84) adskilt av en periode uten mat for en bukk (○) og en simle (●).

Figure 1 shows the dry matter intake of the remaining animals. Average dry matter intake was  $1.1 \text{ kg} \pm 0.4 \text{ kg/day}$  when the animals were eating lichen ad lib.. When they were offered AB-84 after 3 days of starvation average dry matter intake was  $1.1 \text{ kg}$  at day 1, increasing almost linearly to  $2.5$  at day 7, whereafter dry matter intake stabilized in both animals at 4 and 2 kg/day, respectively.

The dry matter percentage of the rumen content was 16 when the animals were eating lichen, 6 after 2 days of starvation and again 17 after eating AB-84 ad lib. for 5 days.

Figure 2 shows the body weight development of the same period. Both animals lost weight when eating lichen, but rapidly gained weight when offered AB-84 ad lib. after the starvation period.

Figure 3 shows ruminal pH, which was  $6.4 \pm 0.3$  when the animals were eating lichen, increasing to 7.4 after 3 days of starvation and dropping to an all-time low of 6.1 twelve hours after refeeding with AB-84 ad lib..

Figure 4 shows the changes in the number of viable bacteria in response to starvation and refeeding. The number was  $4.7 \times 10^{10} \pm 2.7/\text{ml}$  when eating lichen, dropping to  $6.5 \times 10^9 \pm 4.0/\text{ml}$  and  $5.5 \times 10^8 \pm 2.0/\text{ml}$  after 2.5 and 3 days of starvation, respectively. After eating AB-84 ad lib. for 8 days, however, the number was back at  $4.3 \times 10^{10} \pm 1.6/\text{ml}$ .

Figure 5 shows the changes in the number of rumen ciliates in response to starvation and refeeding. When the animals were eating lichen  $1.7 \times 10^6 \pm$

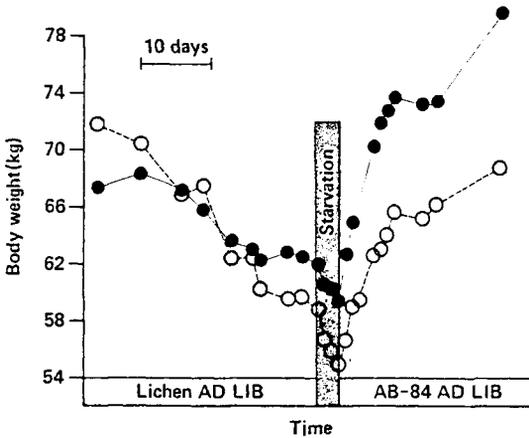


Fig. 2. Body weight of one male (○) and one female (●) Norwegian reindeer while offered lichen ad lib., during 3 days of complete starvation, and while offered a mill «waste product» (AB-84) ad lib..

Fig. 2. Kroppsvektutviklingen for en bukk (○) og en simle (●) som først fikk lav (lichen) ad lib., så sultet og til slutt fikk kornavrens (AB-84) ad lib..

2.7/ml were found. After 3 days of starvation the number had dropped to  $4.3 \times 10^5 \pm 0.6/\text{ml}$ . This represents a loss of 75% of the total rumen ciliate population. The number of rumen ciliates continued to drop (to  $1.8 \times 10^5 \pm 0.5/\text{ml}$ ) the first day after refeeding with AB-84, but was back at  $1.5 \times 10^6 \pm 1.0/\text{ml}$  already after 8 days of eating AB-84 ad libitum.

## DISCUSSION

This study indicates that our mill «waste product» AB-84 is tolerated very well, even when offered ad libitum to reindeer suffering from starvation. Thus, we did not detect signs of severe ruminal acidosis (Fig. 3) and there was a very rapid recovery of both bacteria (Fig. 4) and ciliate protozoa (Fig. 5) upon refeeding with AB-84 after the starvation period. The relatively high fibre content of AB-84 probably stimulates rumination and thereby salivation more than most «highyield» concentrates. Haufman et al. (1979) suggest, that at least 20% crude fibre is required in the diet to give adequate

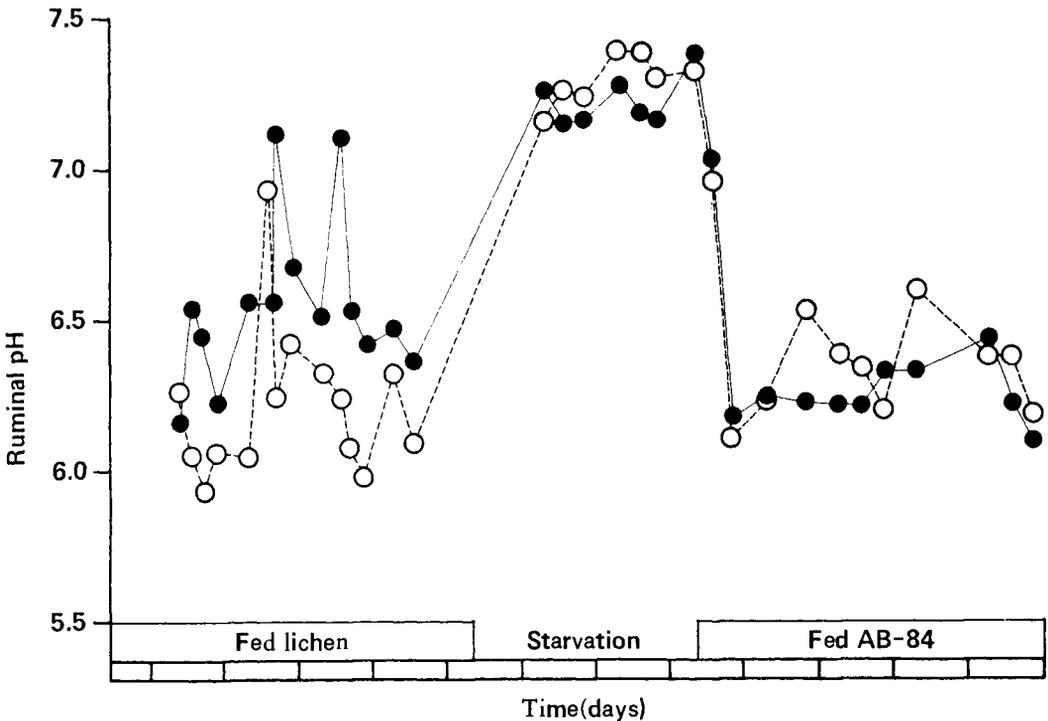


Fig. 3. Ruminal pH of a male (○) and a female (●) Norwegian reindeer, offered first lichen ad lib., and then, after a 3-day starvation period, a mill «waste product» (AB-84) ad lib. Measurements were made at 0900, 1200, 1500 and/or 2000 h.

Fig. 3. pH i vominnhold hos en bukk (○) og en simle (●) først gitt lav (lichen) ad lib., så sultet og dernest gitt kornavrens (AB-84) ad lib., registrert klokken 0900, 1200, 1500 og/eller 2000 hver dag.

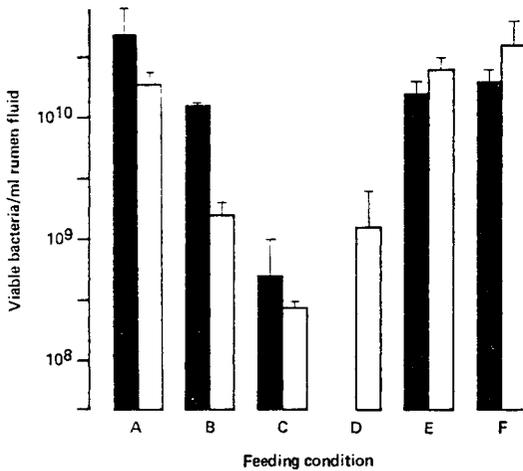
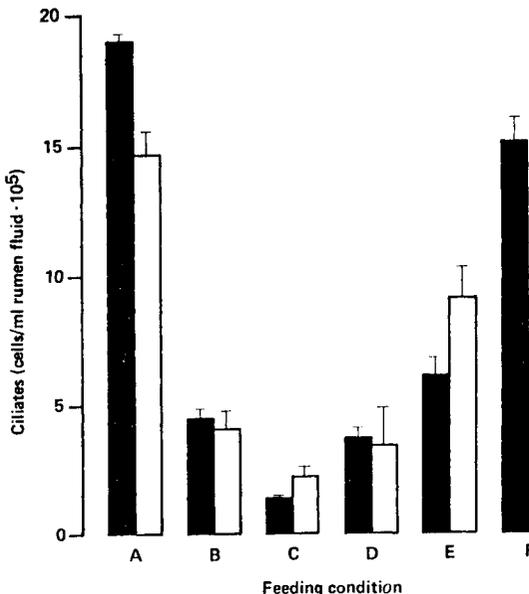


Fig. 4. The number of viable bacteria/ml rumen fluid in two different Norwegian reindeer (mean and standard deviation): A - when eating lichen ad lib.; B - after complete starvation for 2.5 days; C - after 3 days of complete starvation; D - after eating (AB-84) ad lib. for one day; E - for 5 days and F - for 8 days.

Fig. 4. *Levende bakterier pr. ml vominnhold i to reinsdyr (middel verdi ± standard avvik). A - ad lib. tilgang på lav; B - etter 2 dagers sult; C - etter 3 dagers sult; D - etter en dag ad lib. tilgang på kornavrens (AB-84); E og F - etter henholdsvis 5 og 8 dager ad lib. tilgang på kornavrens (AB-84).*



salivation for a satisfactory ruminal pH-regulation.

In this respect the large diameter of the pellets used in this study probably also put a restraint on the ruminal fermentation and thereby avoiding an uncontrolled reduction of pH.

Haufman et al. (1979) has, moreover, reported that the ciliate protozoa may exert a similar effect on ruminal fermentation by their significant uptake of starch. The fact that our AB-84 feed supports the growth of ciliate protozoa instead of destroying them as most concentrates do after abrupt changes in the diet (Dirksen 1970) is in support of the view that the ciliates contribute to the «buffering» of the rumen during excessive intake of carbohydrates. The drop in the number of rumen ciliate protozoa the first day after refeeding with AB-84 is probably due to a temporary increase in the outflow from the rumen following a very low rumen water turnover rate during starvation (Mathiesen, unpublished).

Unlike Bøe and Jacobsen (1981) and Bøe et al. (1982) using the reindeer feed, RF-71, we did not detect any signs of irregular appetite or symptoms of indigestion in our animals when using AB-84. This finding is supported by the fact that the dry matter percentage of the rumen content of our animals was similar after eating AB-84 for five days as compared with when they were eating lichen. The high content of vitamin-B in grain products, known to stimulate appetite in ruminants, could have contributed to the steadily increasing intake of AB-84 after the starvation period in our animals (Fig. 1). The exceedingly rapid increase in body weight during the first few days of refeeding with AB-84, is at least in part caused by a much increased rumen water volume, as compared to when the animals were eating lichen (Mathiesen, unpublished).

Fig. 5. The number of rumen ciliate protozoa/ml rumen fluid in two different Norwegian reindeer (mean ± standard deviation). A - when eating lichen ad lib.; B - after 3 days of complete starvation; C - after eating (AB-84) ad lib. for 1 day; D - for 2 days; E - for 5 days; and F - for 8 days.

Fig. 5. *Antall ciliater pr. ml vominnhold i to reinsdyr (middelverdi ± standard avvik). A - ved ad lib. tilgang på lav; B - etter 3 dagers sult; C - etter en dags ad lib. tilgang på kornavrens (AB-84); D - etter to dagers ad lib. tilgang på kornavrens (AB-84); E og F - etter henholdsvis 5 og 8 dager ad lib. tilgang på kornavrens (AB-84).*

Table 1. Chemical composition of a mill «waste product» (AB-84) as compared with lichen\* (components in percent of dry matter)

*Kjemisk sammensetning av kornavrens (AB-84) og lav (prosent av tørrstoff)*

	Mill «waste product» (AB-84)** <i>Kornavrens (AB-84)</i>	Lichen <i>Lav</i>
Dry matter <i>Tørrstoff</i>	90.8	33.9
Organic matter <i>Organisk stoff</i>	93.6	98.6
Total crude protein <i>Total råprotein</i>	8.5	3.1
Ether extract <i>Eterekstrakt</i>	2.7	1.7
NFE <i>NFE</i>	54.0	61.2
Crude fibre <i>Trevler</i>	19.0	32.6
Ash <i>Aske</i>	6.6	1.4

\* (Data from Jacobsen og Skjenneberg 1976).

\*\* It should be noted that the mill «waste products» may differ from batch to batch - and that the results in this report only relate to the AB-84 composition.

*Det er viktig å være oppmerksom på at sammensetningen av kornavrens kan variere og at resultatene som presenteres her forutsetter en sammensetning som angitt for AB-84.*

Matre (1981) has reported symptoms of mechanical destruction of the intestinal tract when using a mill «waste product» for prolonged periods in cattle. This potential problem has not been investigated in any detail using AB-84 in reindeer, but we have kept reindeer on AB-84 only, for a period of seven months, without apparent ill effects. In any case, there is no need, or reason, for the use of AB-84, or any other concentrate for that matter, for prolonged periods; only in times of nutritional crisis.

In such circumstances it is, of course, imperative that the animals eat what they are offered. Reindeer are notorious for being very selective in what they eat and suspicious of new food-items. Accordingly, one of our animals, a very nervous female, refused to eat our AB-84 feed. Such incidents of poor cooperation could possibly be avoided if the animals of the herd were accustomed to this feed during marking and slaughtering round-ups during summer and autumn.

In conclusion, this study indicates that our mill «waste product» AB-84 is very well tolerated by

reindeer, even after periods of acute starvation. It is moreover commercially available at a favourable price, and could be of interest to reindeer herders. In any case, it should be in the interest of our reindeer management authorities to test it under controlled conditions on a larger scale than we have had the means to do.

#### ACKNOWLEDGEMENTS

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