

MOVEMENTS OF WATER AND SODIUM ACROSS THE RUMINAL EPITHELIUM IN FED AND FOOD DEPRIVED SHEEP

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Introduction

Food deprivation in ruminants causes hyponatraemic hypovolaemia, while the Na concentration of rumen fluid increases, indicating that the Na absorption from the rumen may have been impaired by the treatment (Holtenius and Dahlborn, 1989). It appears that most studies of Na and water transport across the rumen epithelium have been performed with the rumen contents substituted by different buffer solutions. During starvation, changes both in the condition of the rumen mucosa and in the composition of the rumen contents may affect the Na and water transport across the rumen mucosa.

The aim of this study was to investigate how changes in composition of the rumen fluid induced by food deprivation affects water and electrolyte movements across the ruminal mucosa, and to study if food deprivation gives rise to changes in the body, apart from those of the rumen contents, which would affect the transport of water and electrolytes across the ruminal epithelium.

Materials and Methods

Four sheep of the Swedish Fine Wool Breed were used. The sheep were fed 500 g hay and 50 g grain twice daily, except during food deprivation experiments when food was omitted for two consecutive meals. Prior to the experiment the animals were provided with a large rumen fistula in the dorsal sac of the rumen.

The experiment was planned as a 4x4 Latin square design. The sheep were all subjected to the following four combinations: Fed sheep which after rumen emptying got rumen contents from a fed sheep (F → F), food deprived sheep which got rumen contents from a food deprived sheep (D → D), fed sheep which got rumen contents from a food deprived sheep (D → F) and food deprived sheep which got rumen contents from a

fed sheep (F → D). In order to exchange the rumen contents, the rumen was manually emptied of its contents. The oesophagus and the reticulo-omasal orifice were then blocked according to the method described by Engelhardt and Sallman (1972). The contents were kept at +40°C until administered to the rumen of the other sheep. The net flux of fluid was determined by using Co-EDTA and Cr-EDTA as fluid markers. Changes in rumen concentrations of Na and K 10–40 min after the exchange of rumen contents and 10–30 min after an intraruminal load of saline (3 litres of 0.9% NaCl) were determined. The solution was mixed with 50 µCi tritiated water (HTO). The changes in plasma concentrations of Na were measured 10–40 min after exchange of rumen contents and 0–30 min after the intraruminal saline load. Values are presented as the least square mean and the standard error of the least square mean. The data were subjected to an analysis of variance.

Results and Discussion

Feed is the normal source of potassium, and food deprivation should therefore lower the K concentration in the rumen. In present study potassium levels fell from 50±3 to 24±5 mM ($P < 0.01$), while in the same time the Na concentration of the rumen fluid increased from 74±5 to 101±10 mM ($P < 0.05$). Thus, the sum of the K and Na concentration remained constant. Scott (1967) claimed that a drop in the intraruminal K concentration leads to decreased absorption of Na. This could be one explanation of why food deprivation led to increased ruminal Na concentration. The increased ruminal Na concentration was accompanied by a decrease in plasma sodium from 145±1 mM to 142±0 mM ($P < 0.05$) which also has been reported previously (Dahlborn and Karlberg, 1986; Holtenius and Dahlborn, 1989). No net movements of fluid across the rumen epithelium could be detected during the 30 min

after the exchange of rumen contents. However, the net absorption of fluid from the rumen during the 30 min after the saline load was 0.5 l, 0.1 l, 0.3 l and 0.6 l (SE=0.1) for the F → F, D → D, D → F and F → D treatments, respectively. The absorption was significant for treatments F → F and F → D ($P < 0.01$). This indicates that the saline load stimulated fluid absorption from the rumen.

However, animals which received rumen contents from food deprived sheep did not absorb significant amounts of fluid. The alteration of the composition of the rumen fluid due to food deprivation therefore seems to have impaired the ability to absorb fluid. Only in fed sheep which received rumen contents from other fed sheep (treatment F → F) the Na concentration in the rumen fluid decreased significantly. The change was from 96 ± 6 mM to 90 ± 6 mM ($P < 0.01$) during the period 10-30 min after the saline load. The plasma Na concentration had increased from 143 ± 1 mM to 145 ± 1 mM ($P < 0.01$) during the 30 min after the saline load. The net disappearance of Na from the rumen fluid mirrored by the increased plasma Na concentration indicate that there was a substantial absorption of Na from the rumen fluid in the F → F treatment. Thus, it seems as if Na absorption from the rumen is dependent not only of the composition of the rumen fluid, but also of the nutritional status of the animal.

Strozyk (1987) claims that the Na^+/H^+ exchange is the predominant mechanism of Na transport across the ruminal wall, and suggests that the transport is balanced by the energy requiring Na/K-ATPase activity in the basolateral membrane which pumps Na out of the cells. Decreased Na/K-ATPase activity could be an explanation for the impaired Na absorption across the ruminal mucosa of the food deprived sheep in our

study.

The rate of transfer of HTO from rumen to plasma was faster for animals receiving rumen contents from fed animals ($P < 0.001$). Thus it seems clear that the impaired HTO diffusion across the rumen epithelium in food deprived animals (Holtenius and Dahlborn, 1989) was induced by changes in the composition in the rumen fluid, and not in the permeability of the rumen epithelium.

(Key Words: Fluid Absorption, Food Deprivation)

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