

FACTORS AFFECTING ALLANTOIN EXCRETION IN SHEEP URINE

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Allantoin (A) in urine, the end product of nucleic acid purine bases metabolism, appears in sheep to be derived mainly from the nucleic acids of rumen microorganisms responsible for ruminal digestion of feeds. This would imply that A excretion and the ratio (A/C) of A-N to creatinine-N (C, a relatively constant component of sheep urine), should be affected by factors which influence the extent of microbial digestion and synthesis in the rumen or are directly related to the latter.

The purpose of the experiments was to study the effects of incremental levels of dry matter (DM) and metabolizable energy (ME) intake of roughage or concentrate rations by sheep of differentiated body weight, as well as of exogenous nucleic acid supply into the duodenum on the A excretion and A/C ratio in sheep urine. Diurnal variation of A/C ratio was also tested.

Material and Methods

1. Effect of level of feeding

The experiment was conducted on 4 mature wethers of about 60 kg (HW) and 4 wether lambs of about 33 kg (LW) of initial body weight (Columbia breed), kept in metabolic cages. The HW were fed with 5 levels

of finely chopped alfalfa hay (17% crude protein) from 820 - 1690 g DM/d, the LW with 6 levels of concentrate ration (containing 74% ground barley) from 390 - 1080 g DM/d. After completion of this stage and adaptation for 1 month to the alfalfa diet, LW were fed with 4 levels of the same alfalfa hay (from 565 - 1075 g DM/d). DM intake was restricted on the basis of similar levels of feeding (LF) for different treatments. LF, calculated as the ratios of ME intake to ME required to cover maintenance requirement (ME_m) ranged from 0.76 - 1.50 (HW), 0.78 - 1.68 (LW, concentrate) and 0.83 - 1.50 (LW, alfalfa). Both ME and ME_m were calculated using Blaxter's equations Nr. 42 and 53 in MAFF, DAFS and DANI, (1975). Each level of DM was fed during a 10 day preliminary period and 4 days of faeces and daily urine collection. Feed was given in equal portions twice daily at 8.30 and 16.00.

2. Effect of exogenous ribonucleic acid (RNA) supply into the duodenum

The experiment was carried out on 3 mature ewes weighing 50 - 70 kg, fitted with permanent ruminal and T-shape duodenal cannulae as well as with a Folin catheter (Bard, size 18) in the urethra. The ewes were fed a high nitrogen diet (90% alfalfa,

10% concentrate) at maintenance level, twice daily at 8.30 and 16.30. In four 14 day periods (7 days preliminary followed by 3 days of infusions and 4 day post-infusion periods) the ewes were infused intraduodenally twice daily (at 8.30 and 16.30) with 50 ml either of RNA (from yeasts, Sigma) (15, 20 or 30 g/d) or sham (sodium-ammonium phosphate in concentration equivalent to the highest RNA level) solutions. Daily urine was collected during the entire experimental period.

3. Diurnal variation in A/C ratio

It was studied using the same ewes. Urine was collected every 2 h during

48 h period, 1 week after finishing RNA infusion experiment.

A and C in all urine samples were determined colorimetrically by the methods of Young and Conway (1942) and Hawk *et al.*, (1954), respectively. DM and OM contents of feeds and pooled faeces samples were determined according to AOAC methods. The results were subjected to statistical analysis using the Multiple Range Test.

Results and Discussion

Regardless of the type of diet and body weight of sheep, A was correlated with

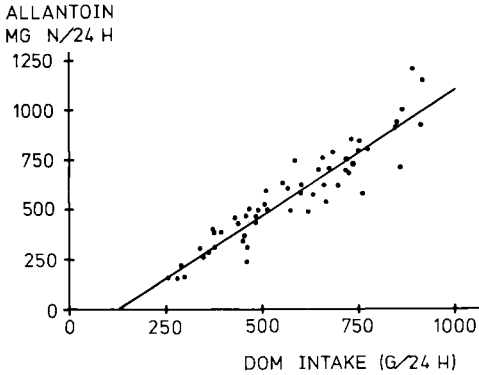


Fig. 1.— The relationship between DOM intake (alfalfa or concentrate ration) and allantoin-N excretion (mean values from 4 consecutive days of collection).

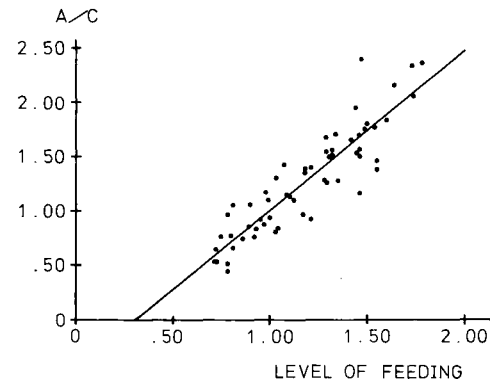


Fig. 2.— The relationship between the ratio of allantoin-N to creatinine-N (A/C) in the urine and the level of feeding expressed as the ratio of ME intake: ME maintenance requirement.

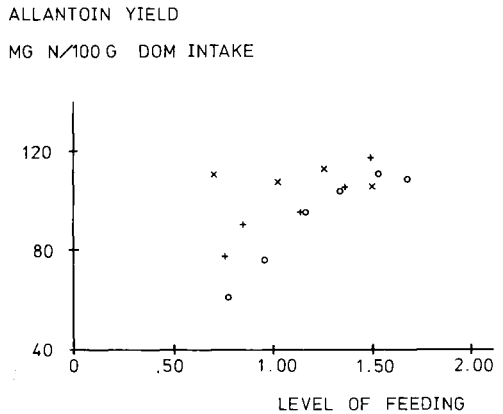


Fig. 3.— The relationship between the level of feeding and allantoin yield; o Wethers ab. 35 kg BW given concentrate ration; x Wethers ab. 42 kg BW given alfalfa hay; + Wethers ab. 60 kg BW given alfalfa hay.

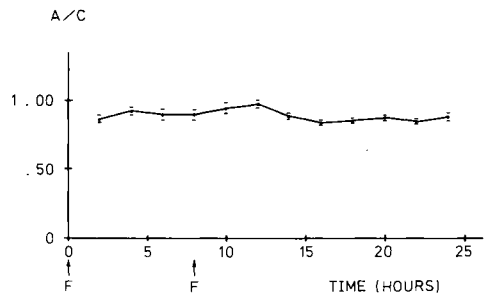


Fig. 4.— Diurnal pattern in the allantoin-N to creatinine-N (A/C) ratio in the ewe urine (mean values for 2 days and 3 animals, \pm SEM).

DOM intake ($r 0.94$, $P < 0.01$), $Y = -161 (\pm 64) + 1.27 (\pm 0.10) X$ (fig. 1). Similarly, A/C ratio was correlated ($r 0.90$, $P < 0.01$) with LF, $Y = -0.46 (\pm 0.19) + 1.47 (\pm 0.16) X$ (fig. 2). Vercoe (1976) found a linear relationship between DDM intake and A excretion in cattle. The differences between the sheep and the cattle consist of the slope of the line and the point of intersection with the Y axis. The latter can be interpreted as an endogenous A excretion. While in cattle it amounted to 1.4 g/d, in the sheep under study the respective extrapolated A value reached zero at about 130 g DOM intake. Previous reports on A excretion in starved sheep were highly inconsistent and this problem is the subject of our further study.

A yields calculated per 100 g DOM intake (AY) did not differ significantly between treatments at feeding above maintenance requirement (fig. 3). Below it, however, changes were observed that could be related to the differences in the body weight of animals and the type of diet. If we accept that A in the urine of sheep originates from exogenous microbial source, the changes in A level might be an indication of net differences in microbial nucleic acids (NA) and, probably, protein synthesis rates. Feeding similar levels (between 750-1080 g DM) of alfalfa hay to HW and LW resulted in A excretion higher by about 30% ($P = 0.01$) in LW, if maintenance requirement of HW was not covered. This, in turn, implicates that growth of microorganisms could be more efficient in smaller wethers because of higher nutrient concentrations in the rumen and/or higher turnover rate (Hogan and Weston, 1970). The AY values about 110 mg N/100 g DOM intake seem to reflect complete covering of microbial nutritional needs in LW. A slight decrease of AY was observed with both types of diet — at

LF 1.50 for alfalfa and higher than that for concentrate (fig. 3). With HW this decreasing pattern was not reached at LF equal 1.50. Rumen microbial metabolic potential was probably higher in the larger animals.

On the average for 3 levels of RNA infused into the duodenum, only about 12% of RNA-N was recovered as A-N. The peaks of increased A excretion were very sharp and essentially finished on the first day of the post infusion period.

Taking into account the above proportion and accepting the average content of 19% of NA-N in microbial total N, one can calculate that between 2.2-3.9 g microbial protein N was synthesized per 100 g DOM intake at AY ranged from 60 to 110 mg N/100 g DOM intake. These values seem to be consistent with those of Hogan and Weston (1970) — 3.1 and 3.7 g N/100 g OM apparently digested in the rumen.

Diurnal variations in A/C ratio were relatively small, especially during the 8 hours of between feeding period. The respective values were decreased by 5-10% during night hours (fig. 4).

For sheep of 8-74 kg body weight C excretion (mean values for 4 consecutive days of collection) was correlated ($r 0.98$, $P < 0.01$) with body weight, with regression equation $Y = -25.44 (\pm 14.63) + 10.48 (\pm 0.35)X$.

The A/C ratio in the urine may be considered as an indicator of the LF (the values are even close numerically). Allantoin excretion is correlated with the dry matter or energy intake and creatinine is correlated with body weight, therefore, also with the maintenance requirement of the animal. At a constant LF this ratio remains fairly constant and is less affected, than the absolute allantoin amount, by such factors as changes in diurnal renal clearance or aberration in collections.

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