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Adaptation of whole animal energy metabolism to undernutrition in ewes

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Adaptation of energy metabolism to undernutrition has often been reported and results in lower calculated maintenance requirements for metabolizable energy. Adaptation with time has also been noted in terms of live-weight changes. However no account has generally been taken of variable physical activity of animals fed different planes of feeding and of the associated energy expenditure. Therefore an experiment was carried out in order to study the effects of undernutrition and of the duration of undernutrition on whole animal energy metabolism in adult, non-lactating, non-pregnant ewes, and on physical activity.

Five 52.7 kg Limousin x Romanov ewes were fed orchardgrass hay first at maintenance (335 kJ ME/d/kg metabolic weight on the basis of initial live-weight, treatment 1M) for 4 weeks (weeks- 4 to - 1) and then at half-maintenance (0.5 M) for 7 weeks (weeks + 1 to + 7). Animals spent 4 days a week in indirect calorimetry chambers for measurements of diet digestibility, respiratory exchanges and time spent standing. Energy expenditure was calculated according to Ortigues *et al* (1993, J Anim Sci, 71, 1947).

Energy digestibility tended to decrease by 6.2 % with undernutrition (52.8 % in weeks - 2 and - 1 to 49.5 % in weeks + 5 to + 7, NS). When underfed, animals lost weight at a similar rate (- 72 g/d from the third day of underfeeding onwards) throughout the whole underfeeding period. Live-weights did not appear to stabilize within the duration of the experiment, as also noted by Kabré and Petit (1994, Anim Prod, 58, 127).

Energy expenditure averaged 6.35 MJ/d at 1M, declined rapidly by 18.4 % ($P<0.01$) within the first week of undernutrition and by an additional 5.4 % between weeks + 1 and + 7 ($P<0.06$). These latter changes were directly related to body weight loss since energy expenditure scaled to metabolic weight remained statistically unchanged at 285 kJ/d/kg metabolic weight during the whole underfeeding period. Efficiency of metabolizable energy utilization for maintenance calculated from measured metabolizable energy intake and energy balance at 1 M and 0.5 M, was 0.71. No adaptation of the maintenance requirement in metabolizable energy (335 kJ/d/kg metabolic weight) was noted with undernutrition, nor with the duration of undernutrition. This conclusion obtained from fed animals (this study as well as Cammell *et al*, 1993, Br J Nutr, 70, 381) differs from that drawn from fasting metabolism studies (Graham and Searle, 1975, Austr J Agri Res, 26, 343).

Underfeeding induced some behavioural adaptation. Indeed, underfed ewes spent less time standing than when fed at maintenance (478 vs 610 min/d respectively, $P<0.04$). This was due to a shorter average duration of individual standing periods in the 0.5 M than in the 1M animals (16 vs 37 min, respectively, $P<0.01$) since the number of standing periods within a day was similar for both groups. Preliminary results obtained from continuous energy expenditure measurements (2 days per animal and per feeding level) showed that the energy cost of standing above that of lying tended to be higher in 0.5 M than in 1M animals (15.2 vs 13.7 J/min/kg live-weight), probably because of increased agitation. Nevertheless the incremental energy expended during standing represented a small proportion of total energy expenditure : 4.2 and 6.7 % in 0.5 M and 1M ewes, respectively. These results are suggesting that the behavioural adaptation noted with underfeeding would have little consequences on maintenance ME requirements.