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Plasma urea dilution patterns in Southdown ram lambs from high and low backfat selection lines

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ABSTRACT

The responses of ram lambs from the Massey University backfat selection lines to a urea load were measured in order to ascertain whether there were line effects on urea space and to evaluate relationships between urea space and empty body water content. Thirty-six 6-8 month-old ram lambs held in metabolism crates and fed lucerne chaff at 1.3 maintenance, were given 120mg urea/kg through jugular catheters. Plasma urea levels were measured in samples taken before and after the urea load. All animals were slaughtered within 7d of the urea challenge and total body water was determined. In contrast to previous studies, baseline plasma urea levels were not significantly higher in the high-backfat-line animals and were not related to carcass fat or water content. The increases in urea levels following the urea load were greater for the high backfat line at 15min, but not at subsequent sampling times. Clearance rates following the load did not differ between the lines. Correlations between empty body water and estimates of urea space were low, suggesting that this is not a useful means of obtaining body composition information for live sheep at this age. Urea space estimated in several ways was significantly higher for the low backfat line group.

Keywords Plasma urea, ram lambs, backfat, selection lines.

INTRODUCTION

Several studies with the backfat selection lines of Southdown sheep at Massey University have shown that young rams from the high backfat line have higher plasma urea levels (Bremmers *et al.*, 1988; Carter *et al.*, 1989) and lower metabolic clearance rates of urea (van Maanen *et al.*, 1989) than those of the low backfat line. It is possible that the higher urea levels may arise from smaller urea spaces so that the entry of the same quantity of urea would lead to greater increases in concentration. If urea space corresponds to total empty body water as suggested by Bartle *et al.*, (1988), then it should be lower in animals of the high backfat line because of their greater fatness. The current study set out to measure the urea space in young rams from the backfat selection lines by subjecting them to an intravenous urea load. At the same time the usefulness of urea space estimates as an indicator of body composition was evaluated.

MATERIALS AND METHODS

Thirty-six Southdown ram lambs, 18 from each of the Massey University high and low backfat selection lines (Purchas *et al.*, 1982; Kadim *et al.*, 1989), were used with two sires being equally represented in each line. Animals were randomly allocated into three slaughter groups of 12 rams with the age at slaughter ranging from 158 to 233 days. After removal from pasture the animals received a 10-day adjustment period in individual pens during which time they were fed chaffed lucerne hay at 1.3 times maintenance once daily at 17.00h. Fresh water was available *ad libitum*. On day 10 the rams were cannulated as described by Bremmers *et al.*, (1988) and an intravenous urea load (120mg urea/kg body weight) was administered on day 12 as a single bolus of a 300mg/ml solution in physiological saline followed by a 6ml saline flush. Plasma was prepared from blood samples collected over sodium citrate at -60, -40, -20, 15, 30, 45, 60, 75, 90, 105, 120, 180, 240, 300, 360 and 420 minutes. Animals were slaughtered 5-7 days after the urea space measurement using normal commercial procedures following a 17.0 hour fast.

Water content in the blood, head and feet, viscera, skin and in the soft tissue and bone from the dissected left side was determined from triplicate samples as the difference between the fresh sample weight and the weight after drying at 90-100°C for 24h (A.O.A.C., 1984).

General least-squares procedures were used to examine the effects of line, slaughter group, covariates and interactions (Gilmour, 1985). Urea space was estimated by dividing the quantity of urea administered by the increase in urea concentration following the urea load. The values used as estimates of this concentration increase were calculated in 3 ways as follows: **Method (A)**: Baseline-adjusted values of the actual urea concentrations at 15 min (A15), 30 min (A30), 45 min (A45) or the mean of these 3 values (Aav).

Method (B1): The linear regression of log urea concentration on time was used to estimate the increase in urea concentration at zero time by extrapolation within each animal. Values within 2 percent of the final 420 min value were considered to be baseline values (based on intra-assay variability) and only the first of these was included in the regression analysis. The mean number of samples that were within two percent of the final (420 min) sample was 2.14 (range 1 to 5).
Method (B2): As for method B1 except that the baseline was taken to be a straight line from the mean of the pre-load samples at time 0 to the value for the last sample included in the regression analysis. This approach was used because for many animals the urea concentration did not return to the baseline levels over the 420 min (Figure 1).

TABLE 1 Least-squares means for characteristics of Southdown rams from the high and low backfat lines, together with residual standard deviations (RSD) and coefficients of determination (r^2) showing the goodness of fit for the total model used.

Item	Selection line				
	High	Low	Effect	RSD	r^2
Number	18	18			
Age(day)	199	195	NS[c]	6.93	0.91
Carcass Wt. (kg)	14.3	13.7	P<0.10	0.80	0.92
Empty body Wt. (kg)	24.3	25.3	NS	3.68	0.27
Fat depth C (mm)[a]	3.0	1.3	P<0.001	0.74	0.78
Carcass fat %[a]	24.6	22.0	P<0.01	2.55	0.74
Carcass H20 %[b]	53.2	55.1	P<0.05	2.5	0.63
Empty body H20 %[b]	57.1	58.4	P<0.10	2.0	0.67

[a]Covariate = Carcass Wt.
[b]Covariate = Empty body Wt.
[c]NS = P >0.10

RESULTS AND DISCUSSION

Table 1 shows that mean carcass weight was similar for the 2 lines, but that rams from the high-backfat line had a slightly lower mean empty body weight. Backfat depth (C) and carcass fat percentage were greater in the high-backfat line, while carcass water percentage and to a lesser extent empty body water percentage were lower for that line when adjusted for carcass or empty body weight differences (Table 1).

In Figure 1 mean changes in plasma urea levels for animals of the high- and low-backfat lines are plotted against time before and after an intravenous urea load. Pre-load baseline concentrations of urea were slightly higher in high-backfat line rams and this difference was maintained throughout the 420 min sampling period following the load, but the differences were not significant. As outlined in the introduction, previous studies with rams of a similar age and weight from these lines have shown differences in the same direction, but they have been larger and statistically more significant.

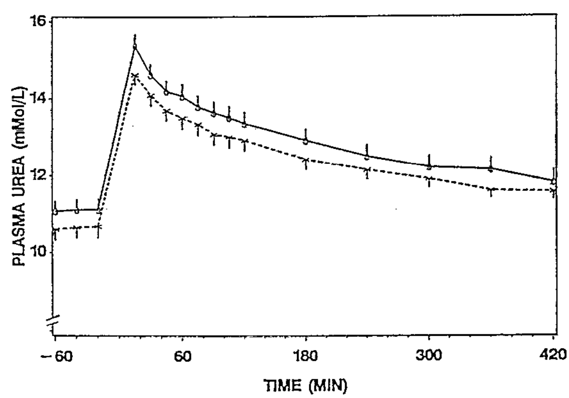

FIG 1 Plasma urea levels (means and SEs) before and after administering a urea load (120mg/kg) at time 0 to young Southdown rams from high (solid lines) and low (dashed lines) backfat selection lines.

TABLE 2 Means and standard errors of empty body water percentage and urea space estimates, together with relationships between estimates of urea space and empty body water.

Item[a]	Mean(SE)	r^2 with actual water (%)	
Empty body water(%)	57.9(0.5)		
Urea Space(% of empty body):			
Method(A):			
(A15)15 min.	69.0(1.3)	0.09	NS
(A30)30 min.	81.7(1.4)	0.22	P<0.01
(A45)45 min.	93.1(1.7)	0.29	P<0.001
(Aav)mean of 3	80.0(1.3)	0.22	P<0.01
Method(B):			
(B1)constant baseline	73.4(1.3)	0.16	P<0.01
(B2)sloping baseline	59.3(1.3)	0.10	P<0.10

[a] For descriptions of urea space estimates see Materials and Methods.

Relationships between weight-adjusted values of carcass water percent, empty body water percent and carcass fat percent (deviations from linear regression lines) were not related to baseline urea concentrations, with simple correlations of 0.01, -0.03 and 0.03, respectively. Mean pre-load baseline values increased with increasing age of animal ($r=0.51$, $P < 0.01$), and there was no significant effect of line on this relationship. This result contrasts with those of van Maanen *et al.* (1989) which showed that urea levels declined with increasing age for lambs from the high backfat line, but remained unaffected by age for the low backfat line. It does not appear that interactions between the effects of selection line and age on urea levels can be predicted with any accuracy.

The increase in plasma urea following the urea load was significantly greater for the high backfat line only at 15 min ($P<0.05$), and the clearance rate, as shown by the slope of the semilog plot, of baseline adjusted urea levels against time, did not differ between the lines.

Overall means with standard errors (SE) for actual empty body water percentage and for urea space estimates expressed as a percentage of empty body weight are given in Table 2 together with relationships between empty body water percent and urea space. Urea space corresponded to actual water space most closely when it was calculated from the semilog plot after adjustments had been made for sloping baselines, with all other methods of calculation overestimating the actual water percentage. The standard errors for all urea space estimates (Table 2) were 2 to 3 times larger than for actual body water percentage. Relationships between urea space and water percentage, although significant in some cases, were not high enough to be useful for predictive purposes.

The use of a urea load as a means of evaluating the body composition of live sheep has been evaluated in a number of studies with the results being inconsistent from one study to another. Generally the method has been most effective when groups of animals have varied widely in composition (Meissner, 1976; Bartle *et al.*, 1988) and has not produced particularly close relationships between urea space and body water when the sheep have had low levels of fatness with little variation between animals (Jones *et al.*, 1982), as was the case for the current experiment. Other factors that may have contributed to the poor relationships in this study are the delay of 5-7d between the time when the urea load was administered and slaughter, and the fact that plasma samples were not taken prior to 15min after the load. If earlier samples had been available it may have been possible to analyse the data using a double exponential model with a mixing phase and a clearance phase (Bartle *et al.*, 1988). When this method was used with the data of the present experiment unreasonable urea space estimates were obtained, apparently because there were insufficient early urea values to allow a clear delineation of the mixing phase.

Table 3 shows that there were no line effects on clearance rates. However, estimates of urea space were consistently higher for the low backfat line, with the size of the line effect often being proportionately larger and of a greater statistical significance than for empty body water percent (Table 1). These results, together with the absence of close relationships between baseline urea concentrations and body composition, suggest that there may have been aspects of protein or urea metabolism that differed between the animals from these two lines or that the ratio of urea space to water space was lower in the high-line rams.

TABLE 3 Least-squares means for urea clearance rates and urea space calculated by two methods for Southdown rams from the high and low backfat lines.

Item[a]	Selection Line				
	High	Low	Effect	RSD	r^2
Urea clearance rates by method B2	0.0096	0.0113	NS	0.0043	0.11
Urea Space estimates(% of empty body):					
Method (A):					
(A15)15 min	65.3	72.7	$P<0.001$	5.83	0.47
(A30)30 min	78.8	84.6	$P<0.05$	6.87	0.44
(A45)45 min	90.1	96.1	$P<0.10$	8.68	0.37
(Aav)mean of 3	76.8	83.2	$P<0.01$	5.47	0.54
Method (B):					
(B1)Constant baseline	70.8	76.1	$P<0.01$	5.95	0.44
(B2)Sloping baseline	56.6	62.0	$P<0.05$	7.31	0.26

[a] Covariate = Empty body weight

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