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The effect of herbage type prior to fasting on the rate of liveweight loss during fasting in ewe lambs

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Abstract

This experiment examined the hypothesis that herbage type, would affect the rate of liveweight loss of Romney lambs after a period of fasting. Lambs (n=80) were allocated to one of two treatments; grass (ryegrass and white clover) and herb-clover (chicory, plantain, red clover, white clover). Lambs grazed their respective treatments for one month prior to the start of the experiment. Lambs were weighed immediately after being removed from their herbage treatment and then at one-hour intervals for eight hours. Herbage type had a significant effect ($P<0.01$) on the rate of liveweight loss over the eight-hour fast. Lambs grazing herb-clover swards had a greater ($P<0.05$) rate of weight loss after four hours than did lambs grazing grass (0.55 vs. 0.23 kg/h, respectively). Similarly, after eight hours, lambs grazing herb-clover lost weight more rapidly ($P<0.05$) than did those grazing grass (0.39 vs. 0.22 kg/h, respectively). These results support the hypothesis that herbage type influenced the rate of liveweight loss during fasting and indicate that farmers need to consider the type of herbage and time off herbage in order to obtain accurate liveweight data.

Keywords: liveweight loss; measurement error; ewe lambs; feed type

Introduction

Live weight (LW) is an indicator of the current physical state of an animal, and change in LW is a useful tool in assessing how an animal is responding to its current environment (Brown et al. 2005; Wishart et al. 2017). Live weight provides a basis for decision making regarding sheep management, therefore, accurate determination of LW is important. New advances in technology have led to commercially available automated weighing systems. In addition, the advent of electronic scales and use of radio frequency identification (RFID) make it easier to regularly collect live weights of individuals over time (Brown et al. 2015). However, liveweight measurements can be affected by a number of factors including: growth, nutrition, health, stress, physiological state and genotype (Kenyon et al. 2014; Brown et al. 2015).

Live weight is a measure of total body mass and includes muscle, fat, bone, organ, body fluids and gut fill (Wishart et al. 2017). It is relatively stable over a short period of time, but alters over longer time periods in response to environmental and physiological conditions (Coates & Penning 2000; Wishart et al. 2017). The contents of the rumen (fluid and feed) can account for between 10 and 23% of total live weight in ruminants (Hughes 1976; Moyo & Nsahlai 2018). Liveweight fluctuations due to gut fill in ruminants are known to be affected by time since last meal, feed, age and size of the animal, time of day relative to sunrise, ambient temperature, and differences in grazing behaviour (Hughes 1976; Gregorini 2012).

A number of strategies can be used to reduce liveweight variation including removal of feed and water for fixed periods of time prior to weighing, standardizing weighing procedures, taking an average of multiple live weights in a day or across a number of successive days, weighing at a specific time relative to sunrise, standardizing the feed offered before weighing and increasing the number of animals and repetitions of the study (Coates & Penning 2000; Wishart et al. 2017). Such methodologies to reduce variation are time consuming and, therefore, not generally utilised except in experimental situations.

Routine on-farm sheep handling and weighing may involve many animals and mustering from fields of varying distances from the weighing location. This can result in significant delays, when individuals are held for many hours without access to food and water prior to weighing. Delays in weighing can lead to weight loss due to a reduction in gut-fill and body fluid (Burnham et al. 2009; Wilson et al. 2015). In lambs, varying levels of weight loss have been reported within flocks waiting to be weighed. Hughes (1976) reported losses of 0.5 to 1.2 kg (1.8 to 3.8% of initial live weight) after six hours and 1 to 1.7 kg (3.7 to 5.3% of initial live weight) after 12 hours. Burnham et al. (2009), Wilson (2014) and Wishart et al. (2017) reported liveweight losses of 4.2 kg (9.8% of initial live weight), 4.8 kg (7.8% of initial live weight) and 2.9 kg (5.6% of initial live weight), respectively after six hours. These levels of liveweight loss are likely to interfere with a comparison of live weight particularly when small liveweight changes are being investigated. Thus, there is a need for a new approach to determine and adjust for variations in live weight among animals and specific periods of time when sheep do not have access to feed and water while waiting to be weighed. The on-going improvements in weighing equipment, software and data management may offer a solution, as they have capacity for the time stamping of individual animal weights.

To date, no study has investigated the effect of diet on the liveweight loss of sheep. The aim of this study, therefore, was to investigate the effect of feed type (ryegrass-based pasture and herb-clover mix) on the rate of liveweight loss in lambs when removed from herbage.

Materials and methods

Study animals and conditions

The experiment was conducted at Massey University's Keeble farm, New Zealand at the end of autumn in April 2018. During the week that the experiment was conducted, the mean temperature was 13°C (min: 9°C and max: 19°C) and mean precipitation was 0.1 mm (min: 0.0 and max: 0.4 mm) per day.

Six-month-old ewe lambs (n=80) were allocated to one of two dietary treatments: an established ryegrass and white clover dominant sward (grass, n=40) or a chicory, plantain, red and white clover mix (herb-clover, n=40). The lambs were on these treatments for 30 days prior to weighing. The dry matter percentage for grass and herb-clover were 22.2% and 12.2% respectively.

The treatment groups were weighed in the same sequence (i.e., first group to be weighed was always weighed first and last group last), immediately after arriving at the weighing facility from their paddock, and thereafter, they were weighed once every hour for the following eight hours, then returned to their paddocks. The lambs were weighed using Tru-Test™ MP600 load bars and XR5000 weigh head (Tru-Test Group, Auckland, New Zealand). The weighing system collected live weights at a resolution of 0.1 kg for weights between 0 and 50 kg. All measurements were undertaken with approval of Massey University ethics committee.

Statistical analyses

All analyses were conducted using R program version 3.4.4 (R Core Team 2016). A linear mixed-effects model with polynomial time effect was fitted using "nlme", a package for fitting regression for linear and nonlinear models (Pinheiro et al. 2018). Diet type was fitted as a fixed variable, holding time (linear and quadratic) as a covariate while an individual sheep effect was fitted as a random effect. Two way treatment x time interactions were also fitted. An autoregressive correlation structure with (correlated random intercept and slope) was fitted, to account for temporal dependency of nearby time.

Results

Tables 1 and 2, summarize the initial and overall regression model parameters, respectively. Within those models, both linear and quadratic time effects were significant ($P<0.001$). There were also significant ($P<0.05$) two way time x treatment and time^2 x treatment interactions indicating differential weight-loss rates. Grass treatment, being the predominant herbage in New Zealand, was used as the reference group for all comparisons.

Table 1 shows the individual effects of time, diet and their interactions. Average liveweight loss among the four treatments did not differ significantly ($P>0.05$) during the entire holding time. Overall, lambs that had previously grazed the grass treatments had a lower rate of liveweight loss compared to those on herb-clover (Table 1). Consequently, the liveweight loss rates and, thus, the prediction equations for grass and herb-clover based diets were significantly different ($F_{1,323} = 130.90$, $P<0.01$, eta squared ($\eta 2$) = 0.03) (Table 2, Figure 1).

Table 1 Summary of the effects of time and the two diets (grass and herb-clover) on liveweight loss of lambs.

Parameter	Coef (b)	SEM	P value
Intercept	0.09	0.081	0.269
Time	0.23	0.048	<0.000
Time^2	-0.01	0.006	<0.048
Effect of Treatment (Grass as reference group)			
Grass			
Herb-clover	0.04	0.116	0.722
Linear time-by-treatment interactions (Grass x Time as reference group)			
Grass			
Herb-clover	0.35	0.071	0.000
Quadratic time-by-treatment interactions (Grass x Time^2 as reference group)			
Grass x Time^2			
Herb-clover x Time^2	-0.025	0.005	0.005

Table 2 Prediction parameters with standard errors in parentheses for lamb liveweight loss (kg) for the dietary treatments (grass and herb-clover).

	Predictor			
Dietary treatment	Intercept	Time	Time^2	Adjusted R^2
Grass	0.11 (0.056)	0.28 (0.033)	-0.06 (0.005)	0.66
Herb-clover	0.07 (0.068)	0.58 (0.061)	-0.03 (0.005)	0.75

Liveweight loss predictive equations for grass-based diet (LWL = 0.11+0.28Time - 0.06Time^2); for herb-clover based diet (LWL = 0.07+0.58Time – 0.03Time^2) respectively.

Live weight and liveweight change

Initial live weights for lambs on grass and herb-clover treatments were; 38.9±0.93 kg and 40.2±1.03 kg, respectively. Sheep in the herb-clover treatment had a significantly greater ($P<0.05$) rate of liveweight loss compared to those on grass. When all data were combined, the rate of liveweight loss (0.28kg/h) was higher in the first four hours of the study compared to the later four hours (0.11 kg/h). The results further indicated that lambs fed herb-clover (0.55 kg/h, 0.23 kg/h) lost more weight than those on grass (0.39 kg/h., 0.22 kg/hr) during the first four and the entire eight hours, respectively. Results from each of the two treatment groups (grass and herb-clover), in descending order of liveweight loss, showed that lambs lost a significant amount of live weight after four (1.9±0.15 kg or 4.9% of live weight and 1.1±0.13 kg or 2.6%) and (2.8±0.16 kg or 7.3% and 1.80±0.11 4.4%) after eight hours ($P<0.001$).

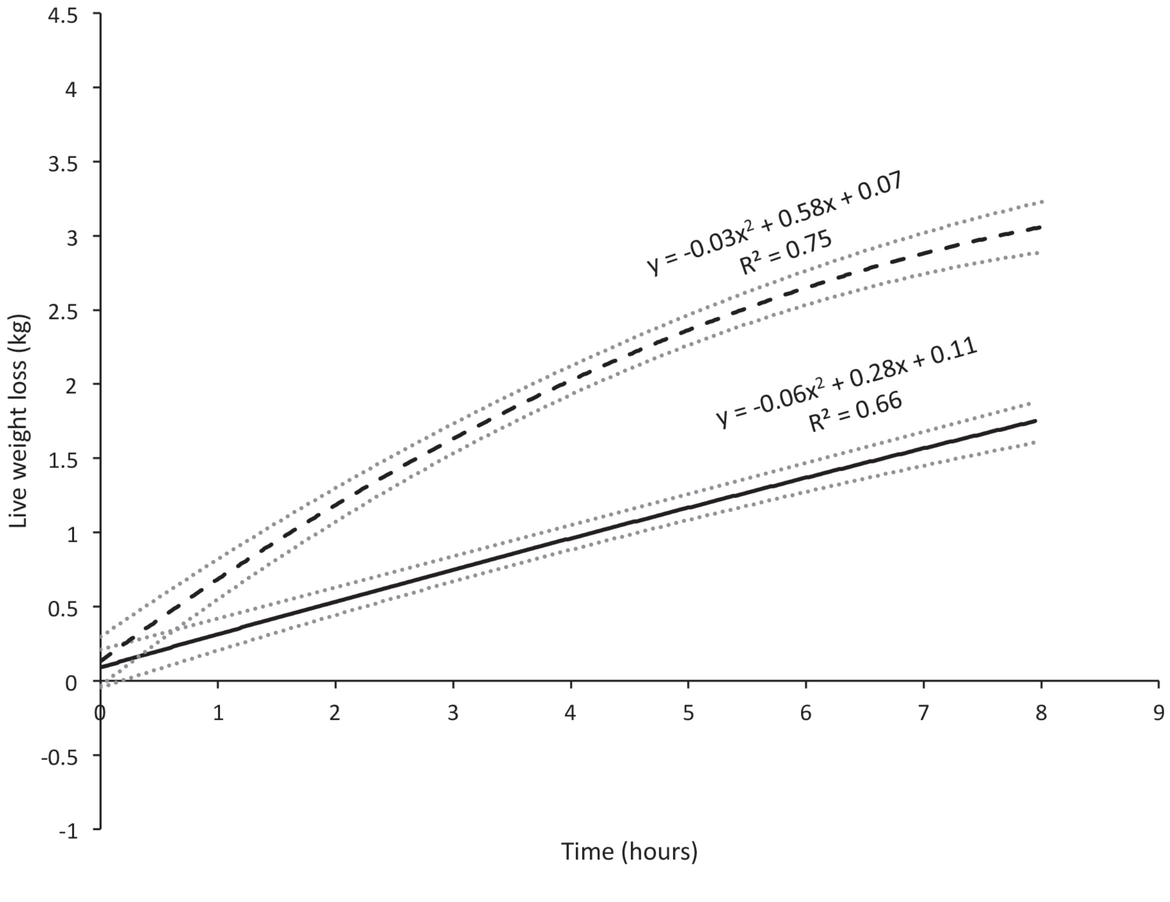
Discussion

The findings of the current study indicated that lambs lost a significant amount of live weight between each weighing throughout the eight-hour fasting period. The magnitude of this change is likely to influence the reliability of liveweight measures, which may have implications for research and management decisions, unless it can be corrected for. The lambs in the current study lost live weight at a higher rate over the first four hours compared to the second four hours. A similar pattern of liveweight loss has been previously reported in sheep (Hughes 1976; Wishart et al. 2017). This was previously attributed to the daily biological rhythms when the digesta from the previous day is passed from the animal in the early morning (Whiteman et al. 1954), or due to the law of diminishing returns (Wilson 2014; Wishart et al. 2017). The liveweight losses in this study were comparable to those reported by Hughes (1976) in two-tooth sheep, Burnham et al. (2009) in hogget ewes at 10 months of age, and Wishart et al. (2017) in non-pregnant dry ewes at 1.5 to 4.5 years of age, but slightly greater than those reported by Hughes (1976) in weaned and un-weaned lambs.

Lambs grazing the herb-clover diet had higher liveweight losses per unit time compared to those on the grass treatment. This may be expected because the herb-clover mix contained a higher concentration of readily fermentable carbohydrate (soluble sugars and pectin) and lower concentrations of structural carbohydrate (i.e., cellulose and hemicellulose) than do grass-based diets (Barry et al. 1999; Moyo & Nsahlai 2018). Further, herb-clover mixes are known to have lower NDF (24-49%) but correspondingly higher organic matter digestibility (68-83%) than grass-based swards (NDF, 36-62%; OMD, 64-74%) (Golding et al. 2011; Somasiri et al. 2016) and, therefore, faster rumen passage (Moyo & Nsahlai 2018). The higher hemicellulose fraction in grasses than in herb-clovers results in higher water-holding capacity and a lower digesta passage rate (Van Weyenberg et al. 2006; Moyo & Nsahlai 2018). Hodgson and Brookes (1999) stated that increases in non-digestible fibre (NDF) concentration can restrict animal feed intake due to low rumen outflow. This suggests that the greater the hemicellulose content in the forage, the greater the amount of water it can hold. This would then result in a decrease in the fractional rate of fluid passing through the rumen and help explain the results.

In order to improve the reliability and comparability of live weights it is recommended that there is standardization of feed prior to weighing of sheep and adjusting for delays. The data here provide information for farmers and scientists to correct live weight with time off pasture. However, further work is required to validate the equations generated in the current study. In addition, further studies are needed to examine factors such as breed, age and sex of lamb, feeding levels, ambient temperature and physiological status that might interact to account for total liveweight loss.

Figure 1 Change in live weight (with 95% confidence interval, dotted lines) after removal of lambs from herbage, for grass (dashed line) and herb-clover (solid line) treatments.



Conclusions

For lambs fed a grass or herb-clover diet, the present study identified liveweight loss profiles during an eight-hour period when feed and drinking water were withheld. This study demonstrated that sheep lose a significant amount of liveweight over a short period of time and this loss rate is dependent on their diet type.

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