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The effect of ewe nutrition on maternal behaviour score and litter survival

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ABSTRACT

Mothering ability was investigated in two breeds of sheep with twin and triplet litters in 2000. The study was carried out on a commercial sheep farm with high reproductive rates gained through intensive selection in its Coopworth flock and the introduction of East Friesian genes by crossbreeding.

East Friesian Coopworth (EFCoop) ewes maintained body condition between pregnancy scanning and lambing whereas Coopworth ewes lost body condition (-0.35 CS). Plasma β-hydroxybutyrate (β-OHB) was significantly higher in Coopworth ewes prior to lambing. Coopworth and EFCoop ewes with triplet litters had elevated levels of plasma β-hydroxybutyrate concentration compared to ewes with twins (0.70 ± 0.03 vs 0.49 ± 002, P<0.0001).

Coopworth ewes had higher triplet litter survival rates to tagging (0.86 ± 0.03) compared with EFCoop ewes (0.68 ± 0.05) (P<0.001). The maternal behaviour score (MBS) of ewes was determined within 24 hours of birth on the basis of their response to the shepherd tagging their lambs on a 5-point scale from 1 (ewe leaves litter and does not return) to 5 (ewe remains within 1m of her litter). The maternal behaviour score (MBS) was higher in Coopworth ewes (3.6 ± 0.04) than the EFCoop ewes (3.4 ± 0.07) and increased with litter size but remained constant for EFCoop ewes regardless of litter size.

The results of this study suggest that ewes that maintain condition in late pregnancy provide a more suitable maternal environment to support their litters. This is increasingly important for triplet litters. This study shows that a ewe that has slightly higher plasma β-hydroxybutyrate levels, is not as receptive to the demands of her litter and is sensitive to human interference as indicated by lower MBS.

Keywords: litter survival; maternal behaviour score; β-hydroxybutyrate; nutrition.

INTRODUCTION

Lamb survival is very important in highly fecund flocks. Triplets become more common as prolificacy increases above 1.7 lambs born per ewe (Amer *et al*., 1999) and greater lamb deaths are expected with triplets than twins or singles (Johnson *et al*., 1982; Hinch *et al*., 1983; Scales *et al*., 1986). Most lamb deaths occur in the first two days after birth and adequate maternal care is required to minimise lamb deaths and minimise the detrimental effects of the environment (Poindron *et al*., 1984). Increased fecundity has highlighted maternal constraints that were less obvious in flocks with lower fecundity prevalent 10-20 years ago when most studies were undertaken. A better understanding of maternal behaviour and the mechanisms which control it should be helpful when assessing existing problems, such as increased lamb mortality.

In late pregnancy and early lactation the nutritional requirements of ewes are high. The last 4-6 weeks before lambing are critical (Scales *et al*., 1986). Nutrition during this period of pregnancy determines lamb birthweight and nutritional disorders of the ewe such as pregnancy toxaemia. In ewes, plasma concentrations of β-hydroxybutyrate (β-OHB) reflect the balance between fat mobilisation and the capacity to utilise ketone bodies produced. Plasma concentration of β-OHB has been used as an index of the inadequacy of intake of nutrients by ewes to meet their energy requirements during late pregnancy (Foot *et al*., 1984). Russell *et al*. (1967) found that ewes with a plasma β-OHB concentration of 0.71 mmoll^{-1} were in energy balance when grazing pasture. ‘Moderate’ under nourishment and ‘severe’ under nourishment gave rise to plasma concentrations of 1.1 and 1.6 mmoll^{-1} respectively. Plasma β-hydroxybutyrate levels rise as more of the body’s energy comes from the metabolism of fats (Guyton, 1991).

This paper investigates ewe body condition and plasma β-OHB concentrations in late pregnancy and describes how they influence mothering and lamb rearing ability in two highly fecund sheep breeds.

MATERIALS AND METHODS

Animals and measurements

Mixed age ewes scanned with twins and triplets in the 2000 lambing season were monitored in this study. There were 432 Coopworth ewes (352 ewes with twins and 80 with triplets) and 103 East Friesian Coopworth cross (EFCoop) ewes (75 with twin litters and 28 with triplets).

At pregnancy scanning ewes carrying twin and triplet foetuses were identified by a Real-time Ultrasound Scanner (24 July 2000; about day 70 of pregnancy) and the stage of gestation was determined. The latter was translated into predicted lambing date (stage 1= 20th - 30th September, stage 2 = 1st - 10th

October and stage 3 = 11th – 30th October). Ewe body condition score was recorded at scanning (CSP).

Blood samples were taken from all ewes two weeks prior to the start of lambing on the 7th September (about day 130 of pregnancy). Plasma β-hydroxybutyrate (β-OHB) concentration was measured in mmoll^{-1}. Ewes were scored for body condition at this time (CSB). Ewe breeds were separated after blood sampling.

Lambing commenced on the 20th September 2000. When the lambs were ear-tagged at between 8 and 36 hours of age, the date of parturition, litter size at tagging, total weight of the litter and Maternal Behaviour Score (MBS) were recorded.

A Maternal Behaviour Score (O'Connor *et al.*, 1985) recorded for all dams was scored on a 5-point scale (low, 1 to high, 5) based on the distance a ewe retreats from her lambs when the shepherd is tagging them.

Litter size at weaning (9th January; mean lamb age 100 days) was recorded and litter survival was calculated from scanning to tagging and scanning to weaning by dividing the latter litter size by the former litter size and it was recorded as a proportion.

Statistical analyses

Ewe performance records were collected and used to generate data sets to enable breed and litter size comparisons using the MIXED procedure in SAS. PROC MIXED uses restricted maximum likelihood (REML) methods to estimate the random effect (SAS, 2002). An univariate linear model was fitted to test for the fixed effects of ewe breed, litter size (at scanning) and the interaction between ewe breed and litter size. To help decide the pathways involved in the differences, several covariates were tested and retained in the model if statistically significant at P<0.05. The fixed effect interaction between ewe breed and litter size was only retained in the model if significant at P<0.05, unless otherwise noted. Least squares means and standard errors for the main factors affecting the trait of interest were estimated.

RESULTS

Coopworth ewes had significantly higher body condition scores at pregnancy scanning and again at prelamb blood testing than EFCoop ewes, even though the ewes were run together up to blood testing (Table 1). However Coopworth ewes lost significantly more body condition through this period than EFCoop ewes and plasma β-OHB concentrations were significantly higher in Coopworth than EFCoop ewes prior to lambing (Table 1).

Foetal number was a significant effect on body condition score at blood testing (P<0.05) but not at pregnancy scanning (P>0.05). Ewes carrying triplet litters had higher body condition scores prior to lambing than ewes carrying twins (3.2 ± 0.04 vs 3.1 ± 0.03). Ewes carrying twin lambs lost significantly more condition (-0.3 ± 0.04) than ewes carrying triplet litters (-0.1 ± 0.05) (P<0.001) however plasma β-OHB levels in ewes carrying triplets (0.70 ± 0.03 mmoll^{-1}) were significantly higher than in ewes carrying twins (0.49 ± 0.02 mmoll^{-1}) (P<0.0001).

The stage of pregnancy significantly affected body condition score at blood testing (β=-0.11 CSB/stage ± 0.028, P<0.0001), change in condition score between pregnancy scanning and blood testing (β=-0.13 CS change/stage ± 0.038, P<0.001) and plasma β-OHB concentrations (β=-0.09 mmoll^{-1}/stage ± 0.020). Ewes that were further through pregnancy had lower condition scores, had a greater change in body condition since pregnancy scanning and had higher plasma β-OHB concentrations.

Plasma β-OHB concentrations were significantly affected by changes in body condition score (P<0.001) and ewes that lost condition had higher β-OHB levels (β=-0.33 CS/mmoll^{-1} ± 0.087).

There were significant breed by litter size interactions for MBS (Table 2). In Coopworth ewes MBS increased as litter size increased. MBS was the same for EFCoop ewes regardless of litter size. Coopworth ewes with triplet litters had significantly higher MBS than EFCoop ewes but there was no significant difference for ewes having twins.

Factors that significantly affected MBS included age of dam (β=0.14 ± 0.025 MBS/year, P<0.0001) and plasma β-OHB concentrations. Ewes with lower plasma β-OHB concentrations had higher MBS at tagging (β=-0.30 ± 0.10 MBS/mmoll^{-1}, P<0.01). There were no significant β-OHB by breed and β-OHB by litter size interactions on MBS (P>0.05). Total litter weight did not significantly affect MBS (P>0.05).

TABLE 1: Body condition score and plasma β-OHB concentration in Coopworth and EFCoop ewes during pregnancy (least squares mean ± standard error).

Pregnancy Trait	Coopworth ewes (n= 432)	EFCoop ewes (n=103)	P (breed)
CS at pregnancy scanning (CSP)	3.6 ± 0.03	3.2 ± 0.05	****
CS at blood testing (CSB)	3.2 ± 0.02	3.1 ± 0.05	**
CS change (CSB-CSP)	-0.35 ± 0.03	-0.09 ± 0.06	****
β-OHB (mmoll^{-1}) prelamb	0.65 ± 0.018	0.55 ± 0.032	**

CS=body condition score. ns = not significant; ** P<0.01; ****= P<0.0001.

TABLE 2: Maternal behaviour score (MBS) in Coopworth and EFCoop ewes with twin and triplet litters (least squares mean ± standard error).

Litter size	Coopworth ewes (n=432)	EFCoop ewes (n=103)	P (breed)
All	3.6 ± 0.04	3.4 ± 0.07	*
Twins	3.3 ±0.04	3.5 ± 0.08	ns
Triplets	3.8 ± 0.08	3.2 ± 0.11	***
P (litter size)	****	ns	

MBS 1=poor, 5=excellent. ns = not significant; * P<0.05; *** P<0.001; **** P<0.0001.

TABLE 3: The effect of ewe breed and litter size on litter survival from scanning to tagging and scanning to weaning (least squares mean ± standard error).

Scanned	Litter survival from scanning (proportion of litter to survive)	Coopworth ewes (n=480)	EFCoop ewes (n=115)	P (breed)
All	To tagging	0.89 ± 0.0167	0.79 ± 0.029	**
Twins	To tagging	0.91 ± 0.015	0.90 ± 0.035	ns
Triplets	To tagging	0.86 ± 0.029	0.68 ± 0.045	***
	P (litter size)	ns	***	
All	To weaning	0.65 ± 0.029	0.68 ± 0.033	ns
Twins	To weaning	0.78 ± 0.038	0.80 ± 0.045	ns
Triplets	To weaning	0.52 ± 0.046	0.57 ± 0.051	ns
	P (litter size)	****	**	

ns = not significant; ** P<0.01; *** P<0.001; **** P<0.0001.

Coopworth (9.8 ± 0.16 kg) and EFCoop (9.9 ± 0.19 kg) dams had similar mean litter weights at parturition (P>0.05). Twin (8.8 ± 0.15 kg) and triplet (11.0 ± 0.20 kg) litter weight differed significantly (P<0.0001). There was no significant breed by litter size interaction. Older dams had heavier litters at birth (β= 0.48 ± 0.11 kg/year, P<0.0001).

Litter survival to tagging was significantly affected by the interaction between breed and litter size (P<0.01). EFCoop dams with triplet litters had lower litter survival rates to tagging whilst Coopworth litter survival to tagging was similar regardless of foetal number (Table 3). Litter weight at birth significantly affected survival to tagging (β=0.01 kg/unit survival ± 0.003, P<0.05).

Coopworth and EFCoop ewes had similar litter survival rates from scanning to weaning (Table 3). There was a non-significant interaction between litter size and breed (P>0.05). The survival of twin litters was greater than the survival of triplet litters from scanning to weaning (0.79 ± 0.03 vs 0.55 ± 0.035). Litter weight at birth had a significant effect on litter survival to weaning (β=0.04 kg/unit survival ± 0.012, P<0.0001).

DISCUSSION

New Zealand research indicates that ewes bearing multiples must be in good condition at parturition if their twins or triplets are to survive and grow to weaning (Geenty, 1997) and this study highlights the importance of maintaining ewe body condition during pregnancy.

Ewe-lamb bonding and lamb survival are maximised by management practices that increase the time spent at the birth site by the dam after parturition (Nowak, 1996). Therefore it is imperative that feeding levels are sufficient at birth and throughout pregnancy to ensure that the ewe is not encouraged to travel from the birth site in search of food.

The energy cost of late pregnancy in the ewe is largely met by increased feed intake, except in very late pregnancy when intake may decline. In this situation ewes must utilise reserves to support the growth of multiples (Jelbart and Dawe, 1984). In this study, Coopworth ewes mobilised maternal tissue as observed in the change of body condition score and higher plasma β-OHB levels during the same period and under the same management conditions as the EFCoop sheep. However, body condition scoring of ewes is a subjective measure indicating the condition held externally; there was no measurement of internal fat stores in this study. Highly fecund breeds such as the East Friesian and their crosses tend to distribute body condition differently maintaining a greater proportion of internal fat stores when compared to Romney and Coopworth breeds (Maijala, 1996).

In this study MBS varied with breed, litter size and plasma concentration of β-OHB. Elevated levels of plasma β-OHB indicate that a ewe's nutritional demand is exceeding feed intake (Foot *et al*., 1984). Plasma concentration of β-OHB prior to lambing was significantly higher in ewes with lower maternal behaviour scores suggesting that a slight increase in plasma β-OHB concentration impairs a ewe's ability to bond effectively with her lambs and may encourage the ewe to travel from the birth site in search of food and become separated from her lambs.

However litter survival was not influenced by plasma β-OHB concentration. All ewes were in good body condition with average scores of between 3.1 and

3.2 in late pregnancy and under nutrition was not evident as indicated by mean plasma levels of β-OHB (Russell *et al*., 1967). However, ewes that lost more body condition from day 70 to day 130 of pregnancy had elevated β-OHB levels and lower MBS.

Slightly elevated plasma β-OHB concentrations in late pregnancy affected maternal behaviour possibly leading to reduced litter survival rates in highly fecund ewes. Further research is needed to determine the extent at which plasma β-OHB concentrations affect behaviour.

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