BRIEF COMMUNICATION: Effect of a fodder beet or lucerne-chaff-based diet on triplet-bearing ewe live weight, body condition score and lamb birth weight

FW Knol[a], C Erichsen[a], A Jonker[a], E Sandoval[a], D Pacheco[a], SY Hea[a] and SA McCoard[a]

[a]*AgResearch Grasslands, Tennent Drive, Private Bag 11008, Palmerston North, New Zealand.*

Corresponding author. Email: sue.mccoard@agresearch.co.nz

Abstract

The objective was to determine whether a fodder-beet based diet (FB) balanced for crude protein, vitamins and minerals could support similar ewe live weight (LW), body condition score (BCS) and lamb birth weight compared to a lucerne-based diet. Triplet-bearing ewes (60-70 days gestation) were randomly allocated to a lucerne-based (65% of dry matter [DM] n=12) or FB-based (56% FB bulb; n=16) diet. Lambs were weighed two hours after birth. Ewe LW (P=0.970) and BCS (P=0.165) did not differ between treatments and there was no diet-by-day gestational age (dGA) interaction. A diet-by-dGA interaction was observed for DM intake (P=0.003) where FB-fed ewes consumed less than control ewes with advancing gestation. A diet-by-sex interaction was evident for lamb birth weight (P=0.026) where female lambs from FB-fed ewes were heavier than female lambs from control-fed ewes, with no difference between males. These results indicate that supplementing a FB-based diet with additional protein, fibre and minerals can maintain triplet-bearing ewe BCS and LW and improve female lamb birth weight compared to those born to control ewes.

Keywords: fodder beet; lucerne; triplets; body condition score; birth weight; sheep

Introduction

Fodder beet (FB, *Beta vulgaris*) is used as a winter feed for pregnant ewes in New Zealand as an alternative feed when there are pasture shortages. It is characterised by high sugar and low dry matter (DM) and crude protein content (Gibbs et al. 2015). Triplet-bearing ewes have 50% greater feed requirements than do ewes with singles (AFRC 1993). The dam's protein and metabolisable energy requirements are greatest in the last six weeks of gestation, when the foetus gains up to 75% of its birth weight (McCoard et al. 2017). Therefore, dietary imbalances and/or feed shortages during mid-late gestation can adversely affect both ewe and offspring performance (McCoard et al. 2017). Progeny of twin-bearing ewes grazing on FB in mid-late gestation have lower lamb birth weight (~0.5 kg) compared to ewes grazing pasture (Sandoval et al. 2017). In that study, the dams exhibited lower body condition score (BCS), especially after 130 days gestational age (dGA), and reduced carcass muscle and fat content at 140 dGA (Hammond, Sandoval, McKenzie, Lees, Pacheco, McCoard, unpublished observations). These results indicate mobilisation of tissue reserves to meet the high nutritional demand of twin-bearing ewes, possibly the result of nutrient deficits and/or a reduction in feed intake when FB is fed. The objective of this study was to determine the effect of a FB-based diet on triplet-bearing ewe DM intake (DMI), live weight (LW), BCS and lamb birth weight compared to a lucerne-based control diet when both diets are balanced for crude protein and minerals.

Materials and methods

This study was conducted at AgResearch Grasslands, Palmerston North, New Zealand and all procedures in this study were approved by the AgResearch Grasslands Animal Ethics Committee (Approval #14459). Triplet-bearing 3-5-year-old composite (Highlander) ewes (BCS: 3.0±0.5; LW: 65-75 kg) with gamma-glutamyl transferase <100 IU/L indicating good liver function, were sourced from a commercial flock at 60-70 days gestation (dGA) as determined by trans-abdominal ultrasonography. Ewes were randomly allocated to FB (n=16) or control (n=12) diet groups balanced for dGA, LW, age, and BCS. The control diet contained 65% lucerne chaff, 28% barley grain, 1.8% minerals and vitamins (Denver Stock Feeds, Palmerston North, NZ). The FB diet contained 56% [of DM] chopped FB bulbs, 30% lucerne chaff, 12% canola meal, 0.5% urea and 1.3% minerals and vitamins. The FB (cultivar 'Rivage') was harvested and kept at room temperature until chopping twice weekly using a Duncan-Ag double-auger fodder chopper (1-8 cm^2 portions) and stored in a chiller until fed. The diets were formulated to be balanced for vitamins and minerals and to meet metabolizable protein and energy requirements for triplet-bearing ewes (AFRC 1993) and also for rumen degradable protein balance (Cannas et al. 2004). On a DM basis, FB bulbs contained 92 g CP, 163 g NDF and 2.2 g P and the supplement fed to the FB group contained 275 g CP, 3331 g NDF and 10.5 g P. The FB diet offered contained therefore approximately 173 g CP, 237 g NDF and 5.8 g P. The control diet contained 188 g CP, 393 g NDF and 6.3 g P. The ME were calculated to be 10 MJ for the control diet and 11.4 MJ for the FB-based diet. Ewes were gradually transitioned from pasture onto their respective treatment diets in group paddocks over six days to reach 30% FB in the diet. Then ewes were transitioned to reach 56% FB in the diet over nine days in indoor individual pens (1.1x3 m) with pine post peelings for bedding over washed river stones. Control ewes were transitioned from pasture outdoors to 100% of their diet indoors over the same time frame. Ewes were fed one third of their daily diet allowance (all ingredients) at

08:30 and the remaining daily allowance at 16:00 hrs. The FB and lucerne components of the FB diet were offered in separate feed bins which allowed collection of separate refusals. *Ad libitum* water and alka-straw (150 g/hd/d; H&T Agronomics, Feilding, NZ) was freely available. All ewes were vaccinated against *Salmonella* (Salvexin + B, MSD Animal Health, Wellington, NZ) and *Leptospirosis* (Leptoshield Novartis) at 96 dGA and Clostridia (Coopers Nilvax Selenised 5:1, MSD Animal Health, Wellington, NZ) at 131 dGA, and treated with a slow-release iodine supplement (Flexidine, Auckland, NZ).

Ewe LW and BCS [1-5 scale (Jefferies 1961), assessed by a single operator] were recorded weekly at the same time of day. Lamb birth weight and sex were recorded two hours after birth. Feed intake was determined as the difference between feed offered and refused and was recorded twice weekly.

The statistical software R (R Core Team, 2018) was used for analysis. A linear mixed model (REML) was used to model the treatment group effect on ewe LW, BCS and DMI and lamb birthweights. A forward selection procedure was used to identify significant predictors in the model. A one-way ANOVA was used to assess the effect of treatment group on the total DMI. The ewe age variable was centred by subtracting every value from the age mean. For the lamb weights, the fixed effect of treatment group and sex and their interaction was used in the model.

Results and discussion

The hypothesis that supplementation of a FB-based diet to meet the crude protein and mineral requirements of triplet-bearing ewes in mid-late gestation will support similar foetal growth and maintain ewe condition compared to a nutritionally balanced lucerne-based diet was supported.

Foetal nutrition is crucial in mid-late gestation as foetal demands increase with advancing gestation (Kenyon & Webby 2007). Lambs of ewes grazing FB with supplementary hay had lower birth weight compared to those of pasture-fed controls, potentially due to a dietary protein deficiency (Sandoval et al. 2017). In this study, there was a treatment-by-sex interaction for birth weight whereby female lambs born to FB-fed ewes were heavier compared to their control counterparts, while there was no effect of treatment on male birth weight (Figure 1). These sex-specific birthweight effects are consistent with observations in prior studies. For example, maternal parenteral arginine supplementation in the last six weeks of gestation in twin-bearing ewes increased foetal growth in females but not males (McCoard et al. 2013). Further research is required to determine mechanisms mediating the sex-specific effect of maternal diet on lamb birth weight.

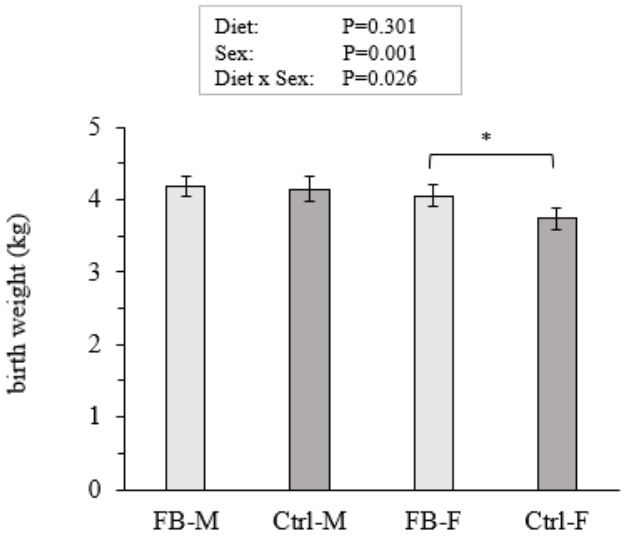
Ewe LW increased with advancing gestation because of increased conceptus mass but there were no LW or BCS differences between treatments (Table 1). Total litter weight (12.04 *vs.* 11.69, P=0.478) and ewe efficiency, estimated as kg of lamb born per kg of DMI (0.11 *vs.* 0.10, P=0.137), did not differ between FB and control ewes. However, a treatment by dGA interaction (P=0.003; Table 1) was observed where daily DMI of control ewes tended (P=0.08) to be greater than that of FB ewes (2.2 vs 1.9 kg/DM/hd/d, average from 120 dGA to term). Although FB ewes had bulky, low DM feed, the high ME content and protein supplementation compensated for the reduction in DMI to support BCS and foetal growth which suggests that ME, CP and minerals did not limit performance.

The DMI of both groups was lower than the feed offer based on AFRC (1993) recommendations for late

Table 1 The effect of diet, day of gestational age (dGA) and their interaction on total daily dry matter intake (DMI), ewe live weight (LW) and body condition score (BCS) of triplet-bearing ewes fed a fodder-beet based (FB) versus lucerne-based control diet from day 84 dGA to birth. Data presented as predicted means ± pooled standard error of the mean (SEM).

dGA	84	91	98	105	112	119	126	133	140	P-value			
										SEM	Diet	dGA	Diet x dGA
DMI (kg/day)													
FB	1.90	1.90	1.90	1.91	1.91	1.91	1.92	1.92	1.93	0.063	0.079	0.005	0.003
Control	1.91	1.90	1.91	1.94	1.99	2.01	2.16	2.27	2.40				
Live weight (kg)													
FB	70.7	72.1	73.8	75.8	78.0	80.6	83.6	86.8	90.3	1.29	0.970	<0.0001	0.874
Control	70.6	72.0	73.7	75.7	78.0	80.6	83.5	86.7	90.2				
Crude Protein intake g/day													
FB	329	329	329	330	330	330	332	332	334	22.59	0.079	0.005	0.003
Control	359	357	359	365	374	378	406	427	451				
ME intake MJ/day													
FB	21.7	21.7	21.7	21.8	21.8	21.8	21.9	21.9	22.0	1.33	0.079	0.005	0.003
Control	19.1	19	19.1	19.4	19.9	20.1	21.6	22.7	24				
BCS													
FB	3.68	3.71	3.73	3.74	3.73	3.71	3.68	3.64	3.58	0.08	0.165	0.002	0.415
Control	3.52	3.55	3.57	3.57	3.57	3.55	3.52	3.48	3.42				

Figure 1 Effect of maternal diet and sex on birth weight of triplet-born female (F) and male (M) lambs from ewes fed a fodder-beet-based (FB) versus control (Ctrl) forage-based diet from day 84 gestation to birth. Data are expressed as mean ± standard error of the mean. *, P<0.05.



pregnancy partially due to the bulk of the feed. Further research is required to determine energy:protein ratios of the maternal diet to support foetal growth in triplet-bearing ewes to optimise ewe feed efficiency.

Acknowledgements

AgResearch Grasslands Ulyatt-Reid Large Animal Facility staff, student interns (Dwayne Shiels, Amellia Redfearn, Federica Campus, Michele Ladu and Jess Slattery, Gabi Gronqvist) and Pohuetai farm staff, Pāmu and Focus Genetics are acknowledged for their assistance with the animal trial and sourcing of animals respectively. We thank H&T Agronomics for provision of the Alka-Straw for the study. This work was funded by AgResearch's Strategic Science Investment Fund (SSIF), and PhD studentship (Cathrine Erichsen) from AgResearch's SSIF-International Linkage Fund and SRUC (Scotland) and the Parkinson Estate (NZ).

References

Agricultural and Food Research Council (AFRC) (Great Britain). Technical Committee on Responses to Nutrients. 1993. "Energy and protein requirements of ruminants" an advisory manual. Wallingford, Oxon, UK: CAB international.

Cannas A, Tedeschi L, Fox D, Pell A, Van Soest P 2004. A mechanistic model for predicting the nutrient requirements and feed biological values for sheep. Journal of Animal Science 82: 149-169.

Gibbs S, Saldias B, White J, Walsh D, Stocker N, Trotter C, Fisher B, Fisher A, Banks, B, Hodge S 2015. A comparison of liveweight gain of two groups of weaners of different entry liveweight in an *ad libitum* fodder beet feeding system for finishing beef cattle. Journal of New Zealand Grasslands 77: 23-28.

Jefferies B 1961. Body condition scoring and its use in management. Tasmanian Journal of Agriculture 32: 19-21.

Kenyon P, Webby R 2007. Pastures and supplements in sheep production systems. Pasture and Supplements for Grazing Animals. Pg. 255-274.

McCoard, S, Sales F, Wards N, Sciascia Q, Oliver M, Koolaard J, van der Linden D 2013. Parenteral administration of twin-bearing ewes with L-arginine enhances the birth weight and brown fat stores in sheep. SpringerPlus 2: 684.

McCoard S, Sales F, Sciascia Q 2017. Invited review: impact of specific nutrient interventions during mid-to-late gestation on physiological traits important for survival of multiple-born lambs. Animal 11: 1727-1736.

R Core Team 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Sandoval E, McCoard S, Pacheco D, Lloyd-West C, Lees S, Hammond K 2017. Feeding fodder beet to ewes in mid-to-late gestation: impact on lamb skeletal size, rectal temperature, and live weights up to weaning. Proceedings of the New Zealand Society of Animal Production 77: 34-36.