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EFFECTS OF DIET AND LIVEWEIGHT ON OVULATION RATES IN ROMNEY EWES

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SUMMARY

Different ewe liveweights (49 kg vs. 39 kg) were generated by differentially grazing two randomly selected groups of mature Romney ewes. A maintenance ration of 25% chaffed barley straw, 15% hay and 60% of either lupin (L diet) or barley (B diet) grain was fed to half of each group. After 31 to 33 days of feeding, the proportions of multiple ovulating ewes were higher for those fed the L diet in both liveweight groups. Injection of 100 µg Cloprostenol on day 8 of the oestrous cycle indicated that the changes responsible for the ovulatory responses to the combined effects of high liveweight and lupins occur before day 8 of the oestrous cycle or during regression of the corpora lutea. High-liveweight ewes had more large follicles on their ovaries but there was no effect of diet on the number of large follicles on the ovaries.

INTRODUCTION

Lupin supplements have increased the ovulation rate in ewes (Knight *et al.*, 1975), but the response has varied between farms (K. P. Croker, pers. comm.) and with time of year (Rizzoli *et al.*, 1975). In a New Zealand trial, Romney ewes have failed to respond to lupin supplements (R. W. Kelly, pers. comm.).

The mechanisms by which liveweight and the quality of the diet influence ovulation rate are unknown. Brien *et al.* (1976) found that lupin-fed ewes had higher plasma FSH concentrations over days 12 to 14 of the oestrous cycle.

This experiment examines the effects of low- and high-protein diets on ovulation rates in ewes of different liveweight. The mechanisms by which liveweight and diet affect ovulation rate are also investigated.

MATERIALS AND METHODS

In December 1977, 160 mature Romney ewes were randomly divided into two groups and differentially grazed to produce a high-liveweight (HLW) and a low-liveweight (LLW) group of ewes. In April, the ewes were randomly subdivided into those to receive a lupin (L) or a barley (B) diet. The four groups of ewes were housed in an animal house. Because of restrictions in pen space the numbers of ewes in the LLW groups were reduced to 30/group.

The L diet consisted of 60% by weight of whole lupin grain (Uniwhite), 25% chaffed barley straw and 15% hay. In the B diet, barley grain was used in place of lupin grain. The crude protein and gross energy contents of the diets were 21.4% and 19 kJ/g, and 11.2% and 18 kJ/g dry matter for the L and B diets, respectively. The diets were fed at the estimated maintenance level (439 kJ ME/kg$^{0.75}$ liveweight) for the mean liveweight of each group. The ewes were weighed twice a week before being fed.

To synchronize oestrus, the ewes were injected with 100 μg Cloprostenol after 4 and 14 days of feeding. The ewes were laparoscoped to determine the number of ovulations (OR_1) 4 days after the synchronized oestrus (E_1) and again (OR_2) 4 days after the second oestrus (E_2). The ewes remained on their diets, and 8 days after E_2 they were injected with 100 μg Cloprostenol, which causes ewes to exhibit oestrus before day 12 of the cycle (Haresign and Acritopoulou, 1978). Ewes from each group were killed 6, 10, 11, 13 and 14 days after the injections. The ovaries were collected and the number of corpora lutea (OR_3) and size of all follicles of 3 mm or greater diameter on the surface of the ovaries were recorded.

Oestrus was detected using 10 vasectomized rams fitted with harnesses and crayons.

The effect of diet and liveweight group on the proportion of ewes with multiple ovulations at each of the three oestruses was determined by fitting models after logit transformation of the data (Nelder, 1975). The liveweight of the ewes just prior to oestrus was included as a covariate in the models.

After natural log transformation of the mean follicle diameter and square-root transformation of the number of large follicles ($\geqslant$ 6 mm diameter), models were fitted to the data to determine the effects of diet and liveweight on follicle size.

RESULTS

The HLW ewes had higher ($P < 0.01$) proportions of multiple ovulations than the LLW ewes at both OR_1 and OR_2 (Table 1). The proportion of multiple ovulating ewes was higher ($P < 0.01$) on the L than on the B diet at OR_2 but not at OR_1 (Table 1). At both OR_1 and OR_2 the liveweights of the ewes just prior to the respective oestruses accounted for most of the differences

TABLE 1: LIVEWEIGHTS (kg) AND PROPORTION OF MULTIPLE OVULATING EWES (OR_1, OR_2 AND OR_3) AT THE THREE OESTRUSES (E_1, E_2 AND E_3)

Liveweight Group	Diets	E_1 Livewt (X_1)	OR_1	E_2 Livewt (X_2)	OR_2	E_3 Livewt (X_3)	OR_3
HLW	L	48.1	0.22	49.0	0.46	48.8	0.49
	B	49.3	0.16	46.8	0.32	47.3	0.14
LLW	L	38.0	0.00	39.3	0.27	39.7	0.14
	B	38.5	0.00	39.9	0.03	38.2	0.10

TABLE 2: MEAN NUMBER OF LARGE FOLLICLES AND MEAN FOLLICLE DIAMETER

Liveweight Group	Diet	Mean No. of Large Follicles	Mean Follicle Diameter (mm)
HLW	L	1.4	5.0
	B	1.2	4.9
LLW	L	1.0	4.6
	B	0.7	4.3

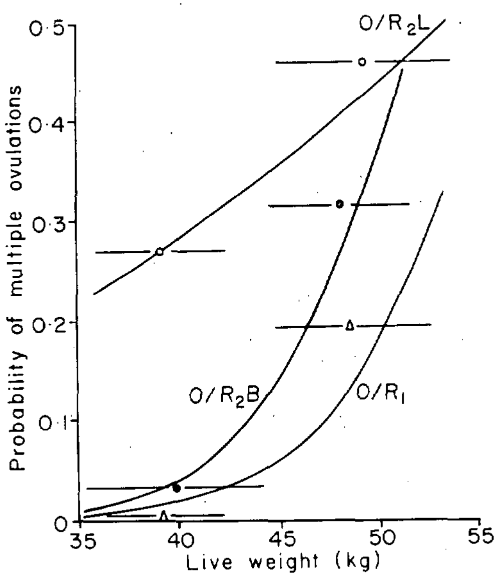

FIG. 1: *The effect of liveweight on the probability of multiple ovulations at OR_1 and OR_2 as calculated from the logit equations. The proportion of multiple ovulations and mean liveweights of the HLW and LLW ewes are indicated by Δ (OR_1), O (OR_2 L diet) and ● (OR_2 B diet), while the horizontal lines indicate the SD of the mean liveweight.*

in the proportion of multiple ovulations between the HLW and LLW ewes ($P < 0.01$).

The effects of liveweight on the probability of multiple ovulations are presented in Fig. 1. There is only one curve for OR_1 since the diets had no effect on the proportion of multiple ovulations, but for OR_2, ewes on the L and B diets have curves with different ($P < 0.01$) slopes and intercepts. The difference in the proportion of multiple ovulations between the two diets is larger at low liveweights and decreases with increasing liveweight (Fig. 1).

At OR_3 there were effects ($P < 0.01$) of both liveweight group and diet on the proportion of multiple ovulations (Table 1). The diet by liveweight by OR_2 vs. OR_3 interaction was significant ($\chi^2_1 = 4.8$; $P < 0.05$) because the proportions of multiple ovulations were maintained in the HLW-L and LLW-B ewes but declined in the HLW-B and LLW-L ewes (Table 1).

There were no significant effects of diet on the number of large follicles or on the mean follicle diameter (Table 2). While both of these variables were larger ($P < 0.05$) in the HLW than the LLW ewes, most of the differences could be accounted for by the liveweight at slaughter ($P < 0.01$).

DISCUSSION

The L diet, fed over 31 to 33 days, increased the proportion of multiple ovulating ewes as compared with the B diet. These differences occurred despite the liveweight and gross energy intake of the ewes being similar. Increased ovulation rate from lupin supplementation has been attributed to the increased protein intake and to the fact that a high proportion of the protein in lupins escapes rumen degradation (Knight *et al.*, 1975). In the present experiment the L diet contained approximately twice the crude protein of the B diet.

Over the liveweight range of 39 to 49 kg, the advantage of the L diet decreased with increasing liveweight. The curves in Fig. 1 suggest that at liveweights above 52 kg there may be no effect of diet on the proportion of multiple ovulations.

The failure of the diets to affect the proportion of multiple ovulations after 14 to 16 days of feeding contrasts with the results of Lindsay (1976), who obtained a response after only 6 days of feeding a lupin supplement. The injections of Cloprostenol 10 days apart may have influenced the response to the L diet at the synchronized as compared with the natural oestrus.

The proportion of multiple ovulations in the HLW-L ewes following the injection of Cloprostenol on day 8 of the oestrous cycle is similar to the previous "natural" ovulations but higer than for the LLW-B ewes. This indicates that the ovarian and/or pituitary changes causing the ovulatory response to the combined effects of high liveweight and the lupin diet occur before day 8 of the oestrous cycle or during the regression of the corpora lutea. By contrast, the decline in the proportion of multiple ovulations for the HLW-B and LLW-L ewes following the Cloprostenol injection suggests that there may be a partial compensatory effect of high liveweight for a low quality diet or a high quality diet for low liveweight which occurs after day 8 of the oestrous cycle.

The increase in the number of large follicles on the ovary with increasing liveweight agrees with previous work (Howland *et al.*, 1966) and may be one of the mechanisms by which liveweight influences ovulation rate. While the diets had no effect on the number of large follicles on the ovary it may influence the proportion of the follicles that become atretic. Lupins increase the FSH concentration over the last 5 days before oestrus (Brien *et al.*, 1976) but not at other stages of the oestrous cycle. FSH levels do not appear to be influenced by liveweight (Knight and Payne, unpublished data).

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REFERENCES

Brien, F. C.; Baxter, R. W.; Findlay, J. K.; Cumming, I. A., 1976. *Proc. Aust. Soc. Anim. Prod., 11*: 273-40.

Haresign, W.; Acritopoulou, S. A. 1978. *Livest. Prod. Sci.*, 5: 313-9.

Howland, B. E.; Kirkpatrick, R. L.; Pope, A. L.; Casida, L. E., 1966. *J. Anim. Sci., 25*: 716.

Knight, T. W.; Oldham, C. M.; Lindsay, D. R., 1975. *Aust. J. agric. Res., 26*: 567-75.

Lindsay, D. R., 1976. *Proc. Aust. Soc. Anim. Prod., 11*: 217-24.

Nelder, J., 1975. General linear interactive modelling. Numerical Algorithms Group, Oxford.

Rizzoli, D. J.; Baxter, R. W.; Reeve, J.; Cumming, I. A., 1975. *Proc. Aust. Soc. Reprod. Biol., 7*: 37.