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Effect of body fat reserves and their variation during lactation on ovarian activity resumption after a spring lambing in Rasa Aragonesa ewes

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SUMMARY - Sixty one Rasa Aragonesa ewes lambing in spring were used to determine the effect of body fat reserves -measured by deuterium oxide- and liveweight on the resumption of sexual activity and ovulation rate after weaning. A 2x2 factorial design was applied, ewes being divided into two nutritional groups (high and low) during lactation and after weaning. There were no significant differences in the length of the interval weaning-first oestrus (114 days, August 15). The deuterium oxide dilution was used to assess changes in body fat content, but was not effective in very depleted ewes. The ovulation rate of ewes fed at high level before and after weaning was higher than in the other groups.

Key words: Sheep, deuterium oxide, sexual activity, ovulation rate, nutrition.

RESUME - *"L'effet des réserves de gras corporel et leur variation pendant la lactation sur la reprise de l'activité ovarienne après un agnelage de printemps chez des brebis Rasa Aragonesa". On a étudié l'effet des réserves de graisses corporelles -mesurées par l'eau lourde- et le poids vif sur le retour de l'activité sexuelle et le taux d'ovulation après sevrage chez 61 brebis Rasa Aragonesa, ayant mis bas au printemps. Dans un essai factoriel 2x2, les brebis étaient classées en deux groupes en fonction du niveau de nutrition (élevé et faible) pendant la lactation et après le sevrage. Il n'y a pas eu de différences pour la durée de l'intervalle sevrage-premier oestrus (114 jours, 15 Août). La méthode de dilution à l'eau lourde utilisée pour définir la masse lipidique corporelle n'a pas donné de résultats fiables sur brebis maigres. Le taux d'ovulation des animaux avec un niveau élevé de nutrition avant et après sevrage a été supérieur par rapport aux autres groupes.*

Mots-clés : *Ovins, eau lourde, activité sexuelle, taux d'ovulation, nutrition.*

Introduction

It has been shown and recently reviewed by Rhind (1992) that nutritional status and body fat reserves greatly determine the reproductive performances of sheep. The study of the effect of body condition on sexual activity and ovulation rate in Rasa Aragonesa ewes has been the objective of this group during the last years (Forcada *et al.,* 1994a,b). Body condition was determined in these experiments by using the method of Russel *et al.* (1969). Although useful in field trials due to its simplicity and easy execution, this method is still a subjective one. A method which gives a more secure assessment of body fat reserves (deuterium oxide) could be a better tool in the studies of the relationships between body condition and reproduction in sheep.

The aim of this experiment was to determine the effect of the variation of body fat reserves, caused by two different planes of nutrition and recorded by the method of deuterium oxide, during lactation and after weaning, on the resumption of cyclicity after a spring lambing in Rasa Aragonesa ewes.

Material and methods

The experiment was carried out at the experimental farm of the Faculty of Veterinary of Zaragoza (Spain) (41° 41' N).

Animals

Sixty one adult Rasa Aragonesa ewes lambing in March were housed in communal yards under natural lighting conditions. Animals were divided into two groups on the basis of liveweight (LW) and body condition (BC) (Russel *et al.,* 1969) at lambing (Abecia *et al.*, 1993a). Ewes of each group were fed 0.6 kg (group H-; n=30) or 0.3 kg (group L-; n=31) of concentrate and 1 kg of ammonia-treated straw, supporting the maintenance requirements of a lactating ewe and the production of 1 (H-) or 0.5 (L-) kg of milk. Mean (± s.d.) period of lactation was 46.74 ± 2.57 days.

The ewes allocated to H- and L- groups during lactation were further divided into two groups after weaning. Animals were then fed 0.5 kg (group -H; n=27) or 0.2 kg (group -L; n=26) of concentrate and 0.8 kg of ammonia-treated straw; these rations being designed to support 1.4 and 1 times the maintenance requirements respectively. Therefore, the animals were distributed in four groups: HH (n=14), HL (n=11), LH (n=13) and LL (n=15), following a 2x2 factorial model. Eight animals were removed from the experiment after weaning.

Methodology

Oestrus was detected daily using aproned rams from weaning to the end of the experiment. Ovulation rate (OR) was measured by laparoscopy 6 days after positive identification of oestrus. LW and BC were determined once a week. Criteria used to evaluate the effect of the treatment on sexual activity were: (i) date of the first oestrus detected by the rams after weaning and length of the interval between weaning and the first oestrus, and (ii) ovulation rate of the first cycle after weaning.

Ten animals of each lactational group were selected to estimate their body fat reserves at three different times: onset of lactation, weaning and two months after weaning, using the deuterium oxide (D_2O) technique (Baucells *et al.,* 1989). Twenty extra animals (10 of each postweaning group) received D_2O at weaning and two months after weaning. Briefly, the method applied was as follows: 0.50 g D_2O/kg LW were infused via jugular catheters 2 hours after feeding the animals. Blood samples were collected 5, 7, 29 and 31 hours after the infusion; water was then extracted by dry-freezing and analysed for D_2O concentration using an infrared spectrometer at 520λ. The D_2O dilution space was defined as the ratio between the amount of D_2O infused and its concentration at the moment of the infusion, which was calculated by extrapolation to zero of the logarithmic regression curve of concentrations (Robelin, 1973). Fat body content was calculated using the equations described by Baucells (1988).

Statistical analysis

Mean (± s.e.m.) was calculated for LW, BC and fat body content at lambing, weaning and 2 months after weaning, the interval between weaning and the first oestrus and ovulation rate of the first cycle after weaning. These parameters were compared by a 2x2 factorial analysis of variance according to the fixed effect model $Y_{ijk} = \mu + X1_i + X2_j + e_{ijk}$; where Y_{ijk} can be LW, BC, fat body content, interval between weaning and the first oestrus or ovulation rate; X1 and X2 are the levels of intake during lactation and after weaning, respectively, and e_{ijk} is the random error. Interactions were not included in the model since they were not significant. Coefficients of correlation between these parameters were also calculated.

Results

Liveweight and fat body content

Neither LW and BC nor body fat reserves were significantly affected by nutritional treatment during lactation (Table 1). Only LW and BC two months after weaning showed significant differences between both postweaning groups (P<0.05).

Table 1. Live weight (kg), body condition, fat body content (kg) at lambing (LWL, BCL, FCL), at weaning (LWW, BCW, FCW) and 2 months after weaning (LW2, BC2, FC2) of ewes fed the maintenance requirements of a lactating ewe and the production of 1 (H-) or 0.5 kg of milk (L-) during lactation, and 1.4 (-H) or 1 times (-L) the maintenance requirements after weaning (mean ± s.e.)

	Lactation		Post Weaning	
	H-	L-	-H	-L
LWL	49.4 ± 1.4	49.0 ± 2.6	-	-
LWW	47.6 ± 2.1	45.2 ± 2.0	46.2 ± 1.9	44.5 ± 1.3
LW2	-	-	47.7 ± 1.9[a]	42.2 ± 1.4[b]
BCL	2.40 ± 0.04	2.42 ± 0.06	-	-
BCW	2.32 ± 0.03	2.26 ± 0.05	2.33 ± 0.05	2.27 ± 0.04
BC2	-	-	2.62 ± 0.03[a]	2.31 ± 0.03[b]
FCL	5.5 ± 0.6	6.0 ± 0.8	-	-
FCW	2.9 ± 0.5	2.6 ± 0.6	3.8 ± 0.5	3.3 ± 0.6
FC2	-	-	6.3 ± 0.6	5.8 ± 0.7

ab: Different superscripts in the same row differ at least P<0.05

Resumption of sexual activity and ovulation rate of the first cycle after weaning

There were no significant differences between groups in the length of the interval weaning-first oestrus (Table 2). The average date was August 15 (114 days after weaning). There was no effect of plane of nutrition on ovulation rate of the first cycle, although those animals in a higher plane of nutrition during lactation and after weaning showed the highest ovulation rate (Table 2). LW and BC at the first oestrus were significantly higher in HH and LH groups at that moment.

Table 2. Length of the interval weaning to first oestrus (W-O, days) and ovulation rate (OR) at the first cycle after weaning (mean ± s.e.), and liveweight and body condition (LW, BC) of ewes fed the maintenance requirements of a lactating ewe and the production of 1 (H-) or 0.5 kg of milk (L-) during lactation, and 1.4 (-H) or 1 times (-L) the maintenance requirements after weaning

Group	W-O	OR	LW	BC
HH	107.9 ± 5.6	1.6 ± 0.1	51.3 ± 1.7	2.7 ± 0.1
HL	114.9 ± 5.2	1.2 ± 0.1	46.9 ± 1.5	2.4 ± 0.1
LH	117.5 ± 6.1	1.4 ± 0.1	49.8 ± 2.0	2.7 ± 0.1
LL	115.7 ± 4.7	1.3 ± 0.2	46.1 ± 1.6	2.4 ± 0.0

Correlation between LW and BC and the reproductive parameters

Neither LW and BC, nor their change over time were correlated with the resumption of sexual activity.

The ovulation rate at the first cycle after weaning was correlated with LW at lambing ($r=0.574$; $P<0.01$) and LW at weaning ($r=0.397$; $P<0.05$). BC and its variation did not affect this parameter.

Discussion

Mean date of the first detected oestrus after weaning was August 15. In previous experiments, the onset of the breeding season of this breed in the same latitude was August 15 in 1988 and August 28 in 1989 (Forcada *et al.,* 1992). Thus, the resumption of sexual activity after weaning was coincidental with the onset of the breeding season. This result is in agreement with Abecia *et al.* (1993b) in an experiment with a similar design but comparing different protein levels after weaning (first detected oestrus after weaning August 28, 1991). Considering that this experiment was carried out during seasonal anoestrus, *postpartum* anoestrus should not be mistaken for the interval between lambing and the onset of the breeding season. The lack of differences between groups confirms those reports indicating that the onset of the breeding season does not depend on nutrition, and that variation between groups could be more important (Hanrahan, 1987).

The study of the relationships between body fat reserves and the reproductive parameters should consider the methodology applied in this experiment. Baucells (1988) observed that the best estimation of body fat reserves was in the range of 60-80% of water in the body; when percentage of lipids is low, the relationship of fat to water in the body is not linear, because the percentage of water cannot be estimated using the usual calibration curve. Thus, the body fat content of ewes at weaning may be underestimated. In contrast, most of the body water contents in the ewes at lambing and 2 months after weaning were in the range of good estimation. Therefore, fat loss during lactation and increase after weaning may be biased. Since the results obtained after the D_2O analysis were not reliable, the possible relationships between the body fat reserves and the reproductive parameters were not considered in the discussion of this experiment.

The ovulation rate of ewes fed at high level before and after weaning was higher than in the other groups. LW at lambing could determine LW at weaning ($r=0.889$; $P<0.001$), when significant differences in LW were observed between groups. It could mean that the effect of plane of intake on OR was mediated through LW at these moments.

The effect of LW during lactation and its variation after weaning on OR could be expressed in two different ways: (i) a "dynamic" effect depending on plane of feed intake and modifying LW during lactation; (ii) higher LW at lambing in H- ewes, and after weaning; (iii) higher LW at the onset of cyclicity in -H ewes, and some "static" effect of LW in a medium term, regardless of level of intake. The problem of D_2O value was not related to intake but on calibration problems in thin ewes.

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