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The effect of body condition at weaning and its subsequent evolution on the resumption of oestrus activity of Rasa Aragonesa ewes

C. DAPOZA
L. ZARAZAGA
C. CASTRILLO
F. FORCADA
DPTO. DE PRODUCCION ANIMAL Y CIENCIA DE LOS ALIMENTOS
FTAD. DE VETERINARIA
UNIVERSIDAD DE ZARAGOZA
ZARAGOZA
SPAIN

SUMMARY - The effect of body condition at weaning and its subsequent variation on the resumption of oestrus activity was studied in thirty-seven Rasa Aragonesa ewes lambing in the anoestrus season (May 7^{th}-14^{th}). The ewes were kept in individual cages during the experimental period and were distributed in two groups according to their body condition score (BCS≥2.5 and ≤2.25). Ewes were given *ad libitum* 3% ammonia treated barley straw, supplemented with either 500 or 250 g/d of concentrate. Digestible organic matter intake (DOMI) was higher in ewes receiving 500 g/d of concentrate and in those with a lower BCS at weaning. Changes in body energy, estimated from the dilution space of deuterium oxide, were better correlated (r=0.70) to DOMI than the changes in live weight (r=0.22) and BCS (r=0.51). Neither did body condition score of the ewes nor the level of concentrate in the diet significantly affect the date of commencement of oestrus activity. The percentage of ewes with oestrus activity after progestative treatment, measured by laparoscopy, was greater in ewes with BCS≥2.5 at weaning than in those with BCS≤2.25 (P≤0.01). Increasing level of supplementation from 250 to 500 g/d promoted higher ovulation rates in ewes with low body condition (P≤0.05).

Key words: Body reserves, ewes, oestrus activity.

RESUME - *"L'effet de l'état corporel au sevrage et son évolution postérieure sur la récupération de l'activité ovarienne chez des brebis Rasa Aragonesa". On a étudié l'effet de l'état corporel au sevrage et son évolution postérieure sur la récupération de l'activité ovarienne chez 37 brebis Rasa Aragonesa ayant mis bas en période d'anoestrus (7-14 mai). Les brebis sont restées en cages individuelles pendant la période expérimentale et on les a distribuées en deux groupes selon leur note d'état corporel (NEC≥2,5 et ≤2,25). Les brebis ont reçu* ad libitum *de la paille traitée à l'ammoniac (3%) supplémentée avec 500 ou 250 g/jour de concentré. L'ingestion de matière organique digestible (MODI) a été plus élevée chez les brebis recevant 500 g/jour de concentré et aussi dans le groupe avec une note d'état corporel au sevrage plus basse. Le changement de la teneur en énergie du corps, estimée par l'espace de dilution du D_2O, a été mieux corrélé (r=0,70) avec MODI que les changements en poids vif (r=0,22) et note d'état corporel (r=0,51). Ni la note d'état corporel des brebis ni le niveau de concentré reçu n'ont significativement affecté la date de la reprise de l'activité ovarienne. Le pourcentage de brebis cycliques après traitement progestatif, déterminé par laparoscopie, a été plus grand chez les brebis avec NEC≥2,5 au sevrage que chez celles avec NEC≤2,25 (P≤0,01). L'augmentation du niveau de supplémentation de 250 à 500 g/jour a provoqué de plus grands taux d'ovulation chez les brebis avec une basse NEC (P≤0,05).*

Mots-clés : *Réserves corporelles, brebis, activité ovarienne.*

Introduction

When the availability of food is not a limiting factor, flock profitability is closely related to reproduction intensification and, in particularly, to the ovulation rate and the reduction in the lag-time between weaning and mating. Flushing can have a positive effect on the ovulation rate, mainly at the beginning of the breeding season (Hulet *et al.*,1974; Thériez, 1984) and in ewes with a low-medium

body condition score (Gunn, 1983). An over-supplementation before mating can even have a negative effect on reproductive parameters in ewes with a high body condition (Rhind *et al.*,1986).

Our study was designed to evaluate the effect of the body condition at weaning and the subsequent food level on the resumption of reproductive activity and ovulation rate in Rasa Aragonesa ewes lambing in anoestrus season.

Material and methods

Animals

The study was carried out at the experimental farm of the Veterinary Faculty of the University of Zaragoza, Spain (latitude 41° 40' N).

Thirty-seven weaned 4-6 years old Rasa Aragonesa ewes averaging 44.14 ± 0.77 kg live weight (LW) were used. Lambing took place in the second week of May 1993 and all the ewes suckled single lambs for 45-50 days. After weaning (June 30th) the ewes were dried off in 4 days by feeding them 500 g/d of ammonia-treated straw as the only food. From 4th July to the beginning of the experimental period (July 7th) the animals received ammonia-treated straw *ad libitum* and 350 g/d of a commercial concentrate (165 g crude protein/kg dry matter). From lambing onwards the ewes were kept in individual cages (1.30 x 1.30 m^2), without males and any artificial lighting. Sunlight during the experimental period averaged 14.5 h/d. Fresh water was available at all times.

Experimental design

At the beginning of the experimental period the ewes were divided into two groups according to their body condition score (BCS): BCS≥2.5 (high-H-score) and BCS≤2.25 (low-L-score). All the ewes received *ad libitum* 3% ammonia treated barley straw (83 g crude protein/kg dry matter), and the ewes in each BCS group were allocated to one of two levels of supplementation (250 and 500 g/d), in a 2 x 2 factorial experimental design. The ewes were allocated in each supplementation level, within each BCS group in such a way as to equalize mean live weight and BCS. The supplement was made up of barley (790 g/kg), soyabean-meal (150 g/kg) and a vitamin-mineral compound (60 g/kg), to contain 156 g of crude protein per kg of dry matter. Both straw and supplement were given in two equal daily meals (9.00 and 18.00 h).

The amounts offered and refusals of straw and concentrate were registered daily and samples were taken once a week to determine their dry matter (24 h at 105°C) and ash content (8 h at 550°C). The individual digestible organic matter intake (DOMI) of each ewe was calculated from registered organic matter intake and the organic matter digestibility (OMD) estimated using the prediction equation: OMD (%) = 54.9 + 0.241X (% concentrate), with non-lactating non-pregnant Rasa Aragonesa ewes (Castrillo *et al.*, 1995).

Animals were weighed weekly and their body condition score recorded at the start and at the end of the experiment using a scale from 0 to 5 points (Russel *et al.*, 1969) with 0.25 subdivision fractions. Each individual BCS corresponds to the mean of three values registered by three different persons.

The body energy content of ewes was determined at the beginning (July 7th-8th) and at the end (September 6th-7th) of the experimental period by the deuterium oxide dilution space method. Each animal was infused through a catheter into the jugular vein with a single dose of marker of approximately 0.5 g/kg of live weight two hours after the first daily food administration. Blood samples were taken from the other jugular vein, 5, 7, 29, 31 hours after infusion in sodium heparin tubes and stored at -20°C. Water from blood samples was obtained by lyophilization and deuterium oxide concentration was measured by infrared spectrophotometry (MIRAN 1FF, Foxboro) at 4.0 µm wavelength using a Ca F_2 cell. The dilution space of deuterium oxide was calculated as the ratio between the quantity of marker infused and its estimated concentration at infusion, obtained by the extrapolation to zero of the marker elimination curve (Robelin, 1977). The energy content of the body

was finally estimated using the equation: Energy (MJ) = -83.65 + 34.803 SLW (kg) -35.869 SD_2O (kg), (R^2 = 0.969, RSD = 27.367 MJ) obtained with F_1 ewes (Romanov x Rasa Aragonesa) slaughtered at different physiological stages (Baucells, 1988), where SLW is the sheared live weight registered at 5-7 hours after-infusion and SD_2O represents the calculated dilution space of deuterium oxide.

Blood samples were taken twice weekly by jugular venipuncture from each animal and assayed for progesterone to detect oestrus activity: small cycles (6-8 day long luteal phase) and normal cycles (17 day long luteal phase). The minimum plasma progesterone level to consider a luteal phase was 0.5 ng/ml (Vosniakou *et al.*, 1989; Forcada *et al.*, 1992a). Plasma was separated by centrifugation and stored at -20°C. Plasma progesterone concentrations were determined with Radioimmunoassay (RIA) (Biomerieux; Marcy l'Etoile, France).The sensitivity of the assay was 0.05 ng progesterone/ml, and intra and interassay coefficients of variation were 11.6 and 13.7%, respectively.

Vaginal sponges with 30 mg of FGA were inserted for 11 days, from day 42 of the experiment (17th August). Ovulation rate was measured by laparoscopy 5 days after sponge removal (2nd September), by using a Sass Wolf GmbH with rigid endoscopy of direct vision 0° and 6 mm diameter.

Two-way analyses of variance were performed to study the effects of initial BCS and level of supplementation, and variables were related by linear regression analysis (Steel and Torrie, 1981). Chi-square test was used to compare percentages.

Results and discussion

The mean values of LW, BCS and body energy content of the ewes at the beginning of the experiment are presented in Table 1.

On average ewes on H-score group had 0.6 points higher BCS (P≤0.001) than those in group L at the beginning of experiment. The former also had higher LW (P≤0.005) and body energy content (P≤0.001). Within each group of BCS, ewes LW and body energy content were similar for both treatments.

Table 1. Live weight, body condition score (BCS) and body energy content of ewes at the beginning of the experimental period

	Initial BCS				RSD†	Significance of effects	
	High		Low			BCS	Supp. level
Supplementation level (g/d)	500	250	500	250			
Number of animals	9	10	9	9			
Live weight (kg)	47.4	46.1	43.0	42.2	4.2	**	NS
BCS	2.6	2.6	2.0	2.0	0.2	***	NS
Body energy (MJ)	421.5	426.0	276.7	306.5	71.3	***	NS

†RSD: Residual Standard Deviation
NS: P>0.05; **P≤0.01; ***P≤0.001

The average daily digestible organic matter intake (DOMI) and increases in LW, BCS and body energy content that the ewes underwent during the experimental period are presented in Table 2 for each treatment.

Table 2. Digestible organic matter intake (DOMI) and increments of live weight (Δ LW), body condition score (Δ BCS) and body energy content (Δ Energy) during the experimental period

Supplementation level (g/d)	Initial BCS				RSD†	Significance of effects	
	High		Low			BCS	Supp. level
	500	250	500	250			
DOMI (g/d)††	789	633	769	672	67	NS	***
DOMI (g/kg $LW^{0.75}$)	43.7	35.7	46.0	40.7	3.1	**	***
Δ LW (g/d)	62.2	55.2	68.1	55.5	30.0	NS	NS
Δ BCS	0.287	0.208	0.537	0.231	0.130	**	***
Δ Energy (MJ/d)	1.133	0.305	1.211	0.616	0.459	NS	***

†RSD: Residual Standard Deviation
††DOMI: DMI x (% OM) x OMD, where OMD (%) = 54.9 + 0.241X, X being the percentage of concentrate in the diet (Castrillo *et al.,* 1995)
NS: P>0.05; **P≤0.01; ***P≤0.001

The ewes receiving 500 g/d of concentrate ate on average 128 g/d more DOM (P≤0.001) than those receiving 250 g/d. When expressed in terms of ewes metabolic live weight, DOMI was greater (P≤0.01) in ewes at low than at high BCS at weaning, because of higher straw intake by low score ewes.

In all treatments average DOMI was greater than theoretical requirements (INRA, 1978) for non-productive animals (26 g/kg $LW^{0.75}$). In consequence ewes in all treatments gained weight and BCS, and body energy content increased during the experimental period.

The greater DOMI of the ewes receiving 500 g/d of concentrate was associated with higher increases of LW, BCS and body energy content compared to the ewes given 250 g/d, although only the last two parameters showed significant differences (P≤0.001). Ewes with low BCS also showed a greater response in these parameters than those with high BCS at weaning, but only the response in BCS was significant. The DOMI (g/kg $LW^{0.75}$) was more closely correlated with the gain in body energy content (r=0.70, P≤0.001) than with LW (r=0.22, P>0.05) or BCS (r=0.51, P≤0.001) gain during the experimental period.

From 7th of July to the date of sponge insertion (17th August) 22 signs of ovarian activity were detected (11 small cycles and 11 complete luteal cycles) for a total of 18 ewes (48.7% of the total ewes), a lower percentage than that found by Abecia *et al.* (1993a) in ewes of the same breed in similar dates (92.5%).

Neither did the level of supplementation or the initial BCS affect the resumption of oestrus activity (Table 3), and no significant correlation were found between changes in LW, BCS and body energy content and the date of resumption of oestrus activity, in agreement with Abecia *et al.* (1993b).

Ninety five percent of the ewes from group H, as compared with 56% in group L ovulated after sponge withdrawal (P≤0.01). Rhind *et al.* (1991) found similar results, attributing the effect to a better hormonal state in ewes with higher BCS. The level of supplementation had a positive effect on the ovulation rate of ewes with a low body condition score (P≤0.01), but not on ewes with a higher BCS at weaning (Table 3). Others authors have also suggested that supplementation before mating has a positive effect on the ovulation rate only in ewes with a low initial body condition score (Gunn, 1983; Forcada *et al.*, 1992b).

Table 3. The resumption of oestrus activity (days after weaning) and ovulation rate

	Initial BCS				RSD†	Significance of effects	
	High		Low			BCS	Supp. level
Supplementation level (g/d)	500	250	500	250			
Number of animals	2	6	5	5			
Days after weaning	32.0 ± 9.0	23.2 ± 4.3	30.2 ± 4.0	30.0 ± 3.9	9.8	NS	NS
Number of animals	9	9	5	5			
Ovulation rate	1.11 ± 0.11	1.11 ± 0.11	1.60 ± 0.24	1.00 ± 0.00	0.35	NS	* ††

†RSD: Residual Standard Deviation
††Interaction BCS x Supplementation level was also significant (P<0.05)
NS: P>0.05; *P≤0.05

Otherwise, all ewes showing double ovulation rate (OR) presented oestrus activity before sponge insertion, whereas only 39% of those showing single OR did (P<0.05). This fact has already been suggested by Abecia *et al.* (1993a) and it can be due to the increased active follicle population that enables a high amount of circulating estradiol in ewes, allowing sustained increments in LH pulse frequency and, consequently a preovulatory estradiol rise, causing the resumption of an oestrus cyclicity at an earlier date.

Table 4 shows the average values of productive parameters depending on ovulation rate. Ewes with a double OR presented a live weight, body condition score and body energy content at weaning similar to that presented by single ovulation ones. Ovulation rate seems to be more related to DOMI and thus to the increments in the ewe's body reserves during the experimental phase, although the only productive parameter differing significantly (P≤0.05) between animals with different ovulation rate was BCS gain.

Table 4. Average values of DOMI, live weight (LW), body condition score (BCS) and body energy content (initial values and increases during experimental period) in ewes with single or double ovulation rate (OR)

	OR = 1	OR = 2	RSD†
Number of animals	23	5	
DOMI (g/kg $LW^{0.75}$)	40.13	43.32	4.48 NS
Initial LW (kg)	45.16	46.86	4.36 NS
Δ LW (kg)	4.04	3.86	2.43 NS
Initial body energy (MJ)	383.7	381.1	78.60 NS
Δ body Energy (MJ)	44.17	59.56	36.35 NS
Initial BCS	2.4	2.3	0.29 NS
Δ BCS	0.26	0.42	0.15 *

†RSD: Residual Standard Deviation
NS: P>0.05; *P≤0.05

Conclusions

The increase in concentrate level from 250 to 500 g/d after weaning in ewes consuming *ad libitum* ammonia treated straw produces an increase in the digestible organic matter intake (DOMI), which induces gains in live weight (LW), body condition score (BCS) and body energy content. Body energy gains were more closely related to DOMI than LW and BCS gains. Animals with a low body condition at weaning show greater DOMI and greater increases in live weight, BCS and body energy content. Neither supplementation level nor initial body condition score have any effect on the resumption of oestrus activity after weaning in the conditions of this experiment. The percentage of ewes showing oestrus activity after progestative treatment is influenced by body condition after weaning. It is more evident in ewes with BCS≥2.5 (95%) than in those with BCS≤2.25 (56%). An increment in supplementation level from 250 to 500 g/d after weaning causes an increase in the ovulation rate in ewes with an initial body condition <2.25, but not in ewes with initial BCS≥2.5. The results of this experiment suggest that ewes of this breed must reach weaning in good body condition in order to optimize the resumption of oestrus activity, even after progestative treatment. Flushing is recommended to enhance ovulation rate if animals are at low body condition at weaning.

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