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Influence of supplementary feeding and the ram effect on conception rate of Barbarine ewes during spring mating

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Abstract. A total of 131 Barbarine adult ewes with an average live weight of 37 kg and an initial body condition score (BCS) of 1.25 were used. The ewes were allocated to treatment groups receiving two levels of supplementation during the 3 weeks prior to and the 4 weeks during mating. Ewes in treatment H were given a diet composed of 0.5 kg of hay and 0.5 kg of concentrate per ewe per day providing 130% of the metabolisable energy for maintenance (MEM) while ewes in treatment L remained underfed during this period and received each per day 0.2 kg of hay and 0.2 kg of concentrate representing 70% of the MEM. All the ewes were synchronised using intravaginal progestagen sponges left *in situ* for 14 days and were introduced to rams at sponges withdrawal. For each feeding regime, approximately half the ewes were artificially inseminated (AI) 24 hours after oestrous manifestation while the remaining ewes were allowed to mate naturally (NM). Ewes that did not hold to artificial insemination were allowed to naturally mate at the return of oestrus. During the first three weeks of application of the feeding regimes, ewes in all treatment groups lost weight and body condition: 36.85 ± 6.45 kg to 32.35 ± 4.64 kg and from 37.4 ± 4.4 kg to 34.4 ± 4.3 kg for the L and H treatments respectively ($P < 0.05$). BCS diminution reached 0.7 ± 0.57 and 0.59 ± 0.48 for ewes receiving the L and H treatment respectively. Neither the feeding regime nor the method of reproduction had a significant effect on fertility at the induced oestrus (36.4, 40, 30.8 and 31.3% for respectively ewes of the LNM, LAI, HNM and HAI groups). The method of reproduction had no effect on total fertility (51.5, 51.5, 64.7 and 67.7% respectively for ewes of the LNM, LAI, HNM and HAI groups). Levels of litter size were low in comparison to the breed mean values averaging 1.0 ± 0, 1.06 ± 0.24, 1.09 ± 0.29 and 1.09 ± 0.30 for respectively ewes of the LNM, LAI, HNM and HAI groups. It is concluded that for light ewes with a very low body condition that have endured several consecutive dry seasons, supplementary feeding for 3 weeks prior to and 4 weeks during mating coupled to stimulation by rams does not alleviate the negative effect of chronic poor feeding on fertility.

Keywords. Sheep – Under-nutrition – Supplementary feeding – Ram effect – Body condition – Fertility.

Influence de la supplémentation et l'effet bélier sur le taux d'ovulation de la brebis Barbarine soumise à une lutte de printemps

Résumé. *Un total de 131 brebis adultes d'un poids vif moyen de 37 kg et une note d'état corporel initiale de 1,25 ont été utilisées. Les brebis ont été réparties en deux lots selon le niveau alimentaire pendant 3 semaines avant et 4 semaines après la lutte. Les brebis du lot H ont reçu 0,5 kg de foin et 0,5 kg de concentré par tête et par jour apportant 130% des besoins d'entretien alors que les brebis du lot B ont continué à être sous-alimentées et ont reçu pendant la même période 0,2 kg de foin et 0,2 kg de concentré, ce qui correspond à 70% des besoins. Les brebis ont été synchronisées avec des éponges pendant 14 jours. Les béliers sont introduits le jour du retrait des éponges. La moitié des brebis de chaque lot est soumise à une insémination artificielle (IA) 24 heures après l'apparition d'œstrus. L'autre moitié est soumise à une lutte naturelle. Les brebis des lots IA sont saillies par les béliers au deuxième œstrus. Durant les 3 semaines d'application du régime, toutes les brebis ont perdu du poids vif et de la note d'état corporel (36,85 ± 6,45 kg à 32,35 ± 4,64 kg et de 37,4 ± 4,4 kg à 34,4 ± 4,3 kg dans les lots B et H respectivement, $P < 0,05$). La diminution de la note d'état corporel a été de 0,7 ± 0,57 et 0,59 ± 0,48 pour les brebis des lots B et H respectivement. La fertilité n'est affectée ni par le régime alimentaire ni par la méthode de reproduction. La fertilité à l'œstrus induit des 4 groupes était faible (36,4, 40, 30,8, 31,3% respectivement dans les lots BNM, BAI, HNM, HAI). La fertilité totale était de 51,5, 51,5, 64,7, 67,7 respectivement dans les lots BNM, BAI, HNM, HAI. La prolificité était faible dans les 4 groupes (1,0 ± 0, 1,06 ± 0,24, 1,09 ± 0,29, 1,09 ± 0,30 respectivement dans les lots BNM, BAI, HNM, HAI). En conclusion, une*

complémentation pendant 3 semaines chez des brebis légères et en mauvais état corporel suite à une succession d'années sèches, ne suffit pas pour pallier l'effet négatif de la sous-alimentation sur la fertilité.

Mots-clés. *Ovins – Sous-nutrition – Complémentation alimentaire – Effet bélier – État corporel – Fertilité.*

I – Introduction

In Tunisia, small ruminants thrive in a semi-arid environment and they depend for their nutrition on the climatic conditions which are characterised by long dry seasons. This situation often leads to animals being in a state of chronic under-nutrition. Supplementary feeding is becoming a common practice during critical phases of the production cycle of sheep particularly in preparation to mating.

Reports on the influence of nutrition on reproduction in sheep may be inconsistent but there is a general agreement that body condition exerts a marked effect on the outcome of reproduction. In this respect, the response of female sheep to supplementary feeding prior to mating is variable according to important factors such as the prevailing level of feeding and body condition. In our conditions, previous findings have reported that ewes of the "Queue Fine de l'Ouest" breed with an optimum live weight responded better to flushing when feed allowances were adjusted to 100 rather than 160 of their metabolisable energy for maintenance (MEM) (Lassoued *et al*., 2004; Rekik *et al*., 2005).

In addition, the period of supplementation is also an important modifying factor of the response to flushing. More evidence is now building up that the most sensitive window of the reproductive axis is day 8 to day 4 before ovulation (Stewart and Oldham, 1986; Nottle *et al*., 1990; Parr *et al*., 1992). However, this sensitive phase of the ovarian cycle might differ as a result of the sheep body condition which is a major limiting factor of the response to flushing.

The aim of this study is to answer the question if a supplementary period of 3 weeks prior to and during mating is sufficient to improve reproductive performances after natural mating or artificial insemination of chronically underfed ewes that have undergone 3 successive dry years.

II – Materials and methods

The experiment was carried out in the sheep experimental station of Bou Rebiaà of the National Institute of Agricultural Research (INRAT, latitude: 36°38' N; longitude: 10°07' E). Figure of the average annual rainfall is 350 mm but during the 3 years that preceded the experiment, annual rainfall respectively reached 309, 306 and 243 mm.

A total of 131 adult Barbarine ewes were used. At the start of the experiment, mean live weight of the ewes was 36.85 ± 6.45 kg and their body condition score (BCS) was low averaging 1.25 ± 0.55. The ewes were allocated to treatment groups balanced for age and live weight. Based on feeding tables by INRA (1988), ewes in treatments H and L respectively received during 3 weeks prior to and 4 weeks of the mating period 130 and 70% of their daily MEM requirements. Diet of ewes in treatment H was composed of 0.5 kg of hay and 0.5 kg of concentrate while diet in treatment L included 0.2 kg of the same hay and 0.2 kg of the same concentrate (85% barley, 12% soybean meal and 3% of a mineral and vitamins supplement). Protein content of the diets in the two treatment groups was adjusted using urea. Concentrate was offered in two equal meals morning and evening. Animals had access to water at all times.

All ewes were synchronised using intravaginal progestagen sponges containing 30 mg fluorogestone acetate and left *in situ* for 14 days. At sponges' withdrawal, teaser rams of the Barbarine breed were introduced to the ewes at a ratio of 1 ram for every 10 ewes. In both treatment groups, approximately half the ewes were artificially inseminated (AI) twice at 24 and 36 hours after being detected in oestrus using 0.2 ml of diluted fresh semen containing 400 10^6 sperm. Only ejaculates with a progressive motility of 3 out of a scale of 5 and with a concentration of at

least 1.2 10^9 sperm were retained. The remaining ewes were naturally mated (NM). Ewes not conceiving at the induced oestrus were allowed to naturally mate at the returned oestrous cycles.

Measurements included variation of live weight and BCS between the start of the experiment and the introduction of rams. At the synchronised mating, oestrous behaviour was monitored every 6 hours for the first 72 hours following rams introduction. Ewes not manifesting oestrus at the synchronised mating were subjected to laparoscopy (Thimonier and Mauléon, 1969) at day 11 after rams introduction to check for the occurrence of silent ovulations. At lambing, the date of lambing and litter size were recorded.

The effect of the nutritional treatment on live weight and body score variations were subjected to an analysis of variance (SAS, 1991). Means were compared with the Duncan test. Between treatment groups, comparisons of the proportions of ewes in oestrus, the proportions of ewes lambing and litter size were carried out using a X^2 test.

III – Results

As shown in Table 1, live weight and BCS figures were similar between treatment groups. Just prior to the induced mating, that is 3 weeks after the application of the nutritional treatments, live weight decreased from 36.85 ± 6.45 kg to 32.35 ± 4.64 kg and from 37.4 ± 4.4 kg to 34.4 ± 4.3 kg for the L and H treatments respectively ($P < 0.05$). The method of reproduction had no effect on live weight variation. Similarly, BCS declined over the same time interval (Table 1) in L than in H ewes with respective figures of 0.7 ± 0.57 and 0.59 ± 0.48.

Table 1. Live weight (LW) and body condition score (BCS) variation between the start of the experiment and introduction of rams

	Treatment groups† (n)			
	LAI (33)	**LNM (33)**	**HAI (32)**	**HNM (33)**
Initial BCS	1.26 ± 0.57[a]	1.30 ± 0.82[a]	1.23 ± 0.43[a]	1.30 ± 0.64[a]
BCS at rams introduction	0.63 ± 0.31[a]	0.59 ± 0.32[a]	0.75 ± 0.31[a]	0.58 ± 0.26[a]
Initial LW	36.9 ± 4.7[a]	36.1 ± 3.7[a]	36.8 ± 4.7[a]	37.8 ± 3.4[a]
LW at rams introduction	32.9 ± 4.5[a]	32.2 ± 4.5[a]	34.1 ± 4.7[ab]	35.2 ± 3.6[b]

†LAI: low treatment group artificially inseminated; LNM: low treatment group naturally mated; HAI: high treatment group artificially inseminated; HNM: high treatment group naturally mated.
[a,b]Means of the same parameter with a common letter did not differ significantly ($P > 0.05$).

Out of the 131 ewes included in the trial, only 50 ewes exhibited oestrus following sponges removal and introduction of rams. Neither the nutritional treatment nor the method of reproduction significantly affected the proportion of ewes manifesting oestrus. Conception rate at the induced oestrus defined as being the number of females lambing out of those detected in oestrus, was low varying between 31 and 40% (Table 2) with no effect of the nutritional treatment and the method of reproduction.

Overall conception rate, a parameter which considers all ewes lambing including those that were conceived at the returned oestrous cycles reached 52% in the L treatment group with no effect of the method of reproduction (Table 2). In H ewes, overall conception rate was higher with improvements of 16% and 13% ($P < 0.01$) in HAI and HNM ewes when compared to those receiving the L nutritional treatment. Litter size was low in all treatment groups varying between 1.00 to 1.09 (Table 2) with no effect of the nutritional treatment or the method of reproduction.

Out of the 81 ewes (62%) not detected in oestrus at the induced mating, laparoscopic observations at day 11 after sponges withdrawal have revealed that only 8 ewes have ovulated in the 4 treatment groups (Table 2).

Table 2. The effect of the level of nutrition and the method of reproduction on reproductive traits

	Treatment groups† (n)			
	LAI (n = 33)	**LNM (n = 33)**	**HAI (n = 32)**	**HNM (n = 33)**
Number (%) of females in oestrus	10 (30)[a]	11 (33)[a]	16 (50)[a]	13 (39)[a]
Conception rate at the induced oestrus (%)	40.0[a]	36.4[a]	31.3[a]	30.8[a]
Overall conception rate (%)	52[a]	52[a]	68[b]	65[b]
Litter size per ewe	1.06 ± 0.5[a]	1.00 ± 0[a]	1.09 ± 0.28[a]	1.09 ± 0.23[a]
Number of females ovulating without oestrus	4	0	3	1

†LAI: low treatment group artificially inseminated; LNM: low treatment group naturally mated; HAI: high treatment group artificially inseminated; HNM: high treatment group naturally mated.
[a,b]Values of the same parameter with a common letter did not differ significantly (P > 0.05).

IV – Discussion

Ewes used in this trial have undergone a severe under-nutrition as a consequence of a succession of the 3 years with insufficient rain fall. In H ewes and despite adoption of feeding allowances that exceeded the MEM, animals continued to deplete their fat body reserves during the course of the experiment. It seems therefore that the INRA (1988) recommendations are not adequate for thin Barbarine ewes under the conditions described in the present experiment. These results on live weight and BCS variation over the three weeks prior to mating, are consistent with the absence of any difference in conception rate at the induced oestrus between all treatment groups. Such an effect of a negative dynamic of live weight and body condition on conception rate has also been reported in other breeds (Cockrem, 1979; Thomson and Bahhady, 1988). In this respect, Lassoued (1998) has demonstrated that when ewes of the Barbarine breed have been undernourished for 6 months before the mating season, conception rate was low (not exceeding 77%) in comparison to the 95% conception rate in ewes that were adequately fed. Nevertheless, the conditions in this trial are more severe and the animals were much more chronically underfed than in other reported experiments explaining the lower levels of conception rate recorded. They also stress out the adaptive capacity of the breed yielding a conception rate of 52 and 68% according to the nutritional treatment at the ram-induced oestrus while their BCS is below 1. This ability of the Barbarine breed to positively respond to the ram effect at spring mating under various degrees of body condition has also been previously reported by Khaldi (1984), Lassoued (1998) and Folch *et al.* (2000).

One important finding in this study is the improvement of conception rate after the end of the mating period. This result is once again an indication of an excellent reproductive fitness of the Barbarine breed. Indeed, when the improvement in the level of feeding (H ewes) was prolonged over the 4 weeks of the mating period, there was an improvement in conception rate comparatively to the restricted level of feeding. This finding could perhaps be used to set, at the level of the field, recommendations for farmers to reason preparation of their animals to mating in the case of extremely feeding conditions as those described here. It is true that the overall conception rates (68 and 65% for both methods of reproduction of the H ewes) are still lower than normal figures of fertility in Barbarine flocks (Khaldi, 1984) during normal climatic conditions, but they could represent a good return value for the extra feed distributed.

Conception rates following AI in this study are within the values reported for this breed (Rekik and Ben Sassi, 1996). It must however be pointed out that these conception rates are obtained after synchronisation with progestagens and the ram effect as a substitute to the use of ECG as previously reported by Rekik *et al*. (2003, 2005). Using such a synchronising protocol, the intensity of anoestrus could be an important variation factor of the AI success rate because it modifies the

sequence of events leading to ovulation, in particular the timing of the LH pre-ovulatory surge (Lassoued, 1998). It is unlikely that this could have had any effect in this trial as the animals were inseminated after observation of oestrus at not at a fixed time.

V – Conclusion

This study showed that thin Barbarine ewes in a very poor body condition at the approach of mating yielded low fertility even when fed above their maintenance requirements (130%). When this improved plan of feeding is applied for 3 weeks prior to mating or prolonged over 4 other weeks of the mating period, conception rates were still lower than the normal figures of fertility reported for the breed when animals are in an adequate body condition.

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