Supplementing Barbarine ewes every two days around mating does not hamper the reproductive performance in comparison to daily supplementation

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Keywords

Sheep, Barbarine ewes, feed supplement, reproductive performance, Tunisia

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Summary

Seventy Barbarine ewes were divided into two homogeneous groups and received 1200 g/head/day of hay, supplemented with 400 g/head/day of concentrate, either daily (group C) or every two days (group A). The supplementation lasted three weeks before and three weeks after the mating period. The live weight, body condition score and blood metabolites were measured at the start and end of the trial. Estrus detection was performed twice a day and ovarian activity was monitored by endoscopy 10 days after estrus onset. There was no significant difference ($p > 0.05$) between groups C and A for the ovulation rate (1.78 ± 0.81 vs 1.69 ± 0.64), fertility at first estrus (58.8% vs 68.6%), total fertility (79.4% vs 82.9%), reproductive productiveness at first estrus (1.54 ± 0.89 vs 1.39 ± 0.81), total reproductive productiveness (1.48 ± 0.57 vs 1.39 ± 0.62), and reproductive losses (43.6% vs 44.1%), respectively. Concentrations of blood metabolites were similar ($p > 0.05$) in both groups. These results suggest that less frequent supplementation during the mating period may be an alternative to reduce feeding costs without affecting the reproductive performance of prolific ewes reared in arid environments.

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■ INTRODUCTION

The nutritional level influences almost all aspects of the reproductive performance starting from oocyte quality to fetal quality and competence (Ferguson et al., 2003; Adamiak et al., 2005). Supplementary feeding is needed during critical physiological stages such as the mating time, late pregnancy and early lactation, particularly in prolific sheep, for which feeding strategies are different from non-prolific breeds (Lassoued et al., 2004). Working with a British breed, Rhind et al.(1989) stated that a low feed intake before mating reduces the mean ovulation rate and a low intake after mating induces a higher rate of ovum wastage. In Mediterranean regions, regular food supply is not guaranteed and small ruminants living in a semiarid environment depend for their nutrition on climatic conditions, characterized by long dry seasons. This situation often leads to supplementary feeding which is becoming a common practice during critical phases of the production cycle of sheep. It appears, however, that the reproductive response to improved plans of nutrition depends on the breed and body condition of animals (Lassoued et al., 2004). Indeed, in the highly prolific D'Man breed, higher levels of nutrition before and during mating are associated with an improved reproductive performance, similarly to that which has been reported for several sheep breeds (Lassoued et al., 2004). For the low prolific Queue fine de l'Ouest (QFO) ewes, increasing the level of nutrition by using more concentrate did not improve the ovulation rate (Rekik et al., 2007), but it substantially lowered the litter size as a result of higher reproductive wastage (Lassoued et al., 2005). In semiarid Tunisia, concentrates are very often used in large quantities to supplement animals.

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For small farmers, the high cost of the concentrates as well as their limited availability hampers their wide-scale use (Ben Salem et Nefzaoui, 2003). Several researchers have shown that irregular (not daily) supplementation of crude protein to ruminants consuming low-quality forage can reduce the costs associated with supplementation, while maintaining an acceptable performance, nutrient intake and nutrient utilization in comparison with daily supplementation (McGuire et al., 2013).

To our knowledge, there is a lack of research on the effect of irregular supplementation on reproductive performances, particularly in small ruminants during the mating period. The aim of this study was to evaluate the effect of a concentrate supplementation every other day on the reproductive traits of prolific Barbarine ewes. We hypothesized that reducing the conventional daily frequency of supplementation to every two days would maintain an acceptable reproductive performance while generating important savings for the farmers.

■ MATERIALS AND METHODS

Study location

The trial was carried out at the sheep experimental farm of Ousseltia of the National Institute of Agricultural Research of Tunisia (INRAT). The farm is located in central, semiarid Tunisia at 35°51' N and 9°35' E, with an average annual rainfall of 594.7 mm. The area experiences a Mediterranean-type climate with cool winters (< 4,4°C temperatures) and hot dry summers (> 35°C).

Animals

The ewes used in this trial belonged to the 'W' flock, established after selection in 1979 of prolific ewes among the fat-tailed Barbarine sheep. Over a period of 20 years (1979–1998) the calculated mean reproductive productiveness of the flock was 1.6 (1.4 minimum and 1.8 maximum) (Bedhiaf-Romdhani et al., 2013).

Treatments

The trial was carried out during the period of the lowest sexual activity when none of the ewes showed spontaneously estrous or ovarian activity. The supplementation started on May 22 and lasted for six weeks.

Seventy W Barbarine ewes aged 5.2 ± 1.3 years were randomly allocated to two homogeneous treatment groups (mean live weight [LW] ± SD = 33.9 ± 6.4 kg). Each group received 1.2 kg/head of hay and was supplemented with 0.4 kg/head of concentrate (mixture of 80% barley + 17% soybean meal + 3% mineral and vitamin complement) either daily (control group C) or every two days (group A). The hay and concentrate were distributed in two equal parts at 08:00 and 16:00. Supplementation was distributed during three weeks before and three weeks after male introduction. The quantity of concentrate was calculated so that the whole diet provided 1.5 of the daily metabolizable energy (ME) of maintenance requirements estimated at 0.397 MJ ME kg $LW^{0.75}$ (Jarrige, 1988). The crude protein content is lower in straw than in concentrate (4.11% vs. 13.98% on a dry matter basis). Animals had free access to clean and fresh water during the entire trial.

Mating management

The ewes were subjected to estrus synchronization using intravaginal progesterone pessaries impregnated with 40 mg fluorogestone acetate and left *in situ* for 13 days. Mating took place by introducing rams at the time of pessary removal, at a ratio of one ram to seven ewes. Throughout the mating period, rams were continuously rotated between the two groups of females. Ewes detected in estrus were hand-mated twice: immediately after being detected in estrus and 12 hours later. For the animals not holding to the induced estrus, mating continued until the end of the experiment (70 days following introduction of rams).

Measurements

Ewes were weighed and scored for body condition before the morning feeding, at the beginning and at the end of the trial. Two scores were given to each ewe on a scale from one to five. The dorsal score was measured using the technique of Russel et al. (1969) and the tail score was determined using Atti's method (1992), exclusively based on fat tail measurements.

Blood samples were collected from the jugular vein at the beginning and at the end of the treatment using evacuated blood collection tubes. Blood was immediately centrifuged (3000 tour/min) for 20 min and plasma harvested and stored (-20°C) until the analysis. The ovulation rate was assessed by laparoscopy (Thimonier et Mauléon, 1969), 9–11 days after the onset of behavioral estrus. After lambing, the fertility and reproductive productiveness obtained in the first estrus, and the total fertility and total reproductive productiveness obtained after the mating period was over were recorded. Finally, for each ewe, the difference between the numbers of corpora lutea and lambs born was termed 'reproductive wastage' (it included unfertilized ova and early embryo losses [Lassoued et al., 2004]).

Analysis of the metabolites

All metabolites were analyzed with the automaton DialabAutolyser based on the following methods: triglycerides / enzymatic colorimetric methods (GPO-PAP); creatinine / colorimetric kinetic method without deproteinization; glucose / enzymatic method (GOD-PAP); total proteins / colorimetric method biuret; cholesterol / enzymatic colorimetric test (CHOD-PAP); urea / Berthelot modified method.

Statistical analysis

Data were analyzed with SAS general linear model (SAS, 2004). Means per treatment were compared by the least square means option. Fertility was analyzed using the chi-square test. Plasma metabolites were analyzed with SAS repeated measure (significance at $p < 0.05$).

■ RESULTS AND DISCUSSION

Live weight and body condition score

Supplementing ewes every two days with concentrate did not reduce the final body weight which was similar to the live weight of ewes supplemented daily (Table I). In fact, the two groups of females showed a similar live weight gain during the treatment period ($p > 0.05$). Similarly, the body condition score did not differ between the two groups during the study (Table I). The similar increase of body weight and body condition score for the ewes supplemented on a daily basis or every two days could be due to the low body weight and body condition score of these animals at the start of the experiment.

For ewes in this experiment, the increase in the feeding level started 21 days before the mean date of mating, therefore, the amount of supplementary feed was probably enough to provide energy and protein, and thus elicit the same weight gain in both groups. This finding calls up the 'flushing effect' commonly reported in sheep flock management, whereby the supply of extra feed before mating improves the reproductive performance (Somchit-Assavacheep, 2011; Ben Khlil et al., 2017).

Reproductive performance

The proportion of females that displayed estrus at least once did not differ between the two groups ($p > 0.05$; Figure 1). For both groups, the estrous response reached 97% during the three days following rams' introduction, with a maximum on day 2. Only four ewes of group A and none of group C returned to estrus 54 days after introduction of rams ($p = 0.36$; Figure 1).

The ovulation rate, fertility and reproductive productiveness at the induced estrus, as well as the fertility and reproductive productiveness after the entire mating period, and the reproductive wastage did not differ between ewes supplemented daily or every two days ($p > 0.05$; Table I).

The fertility rates of ewes in both treatment groups were within the common range usually reported for this prolific strain of the

Table I

Morphometric parameters, plasma metabolites and reproductive performances of ewes supplemented daily (Group C) or every two days (Group A) around the mating period at INRAT sheep farm, Tunisia

Parameters	Group C *	Group A *	P
Initial live weight	34.4 ± 6.7	34.3 ± 6.2	0.97
Final live weight	37.9 ± 7.3	37.7 ± 6.8	0.89
Initial dorsal condition score	1.3 ± 0.3	1.2 ± 0.3	0.35
Final dorsal condition score	1.5 ± 0.2	1.5 ± 0.2	0.6
Initial tail condition score	3.0 ± 0.6	3.1 ± 0.5	0.7
Final tail condition score	4.0 ± 0.7	4.0 ± 0.5	0.85
Cholesterol (mmol/L) beginning	1.37 ± 0.28	1.43 ± 0.19	0.56
Cholesterol (mmol/L) end	1.34 ± 0.24	1.35 ± 0.24	0.92
Creatinine (µmol/L) beginning	75.89 ± 14.18	77.8 ± 9.87	0.83
Creatinine (µmol/L) end	82.60 ± 7.18	81.38 ± 8.23	0.72
Glucose (mmol/L) beginning	2.49 ± 1.49	2.74 ± 1.72	0.74
Glucose (mmol/L) end	2.46 ± 2.77	1.93±1.43	0.60
Total protein (g/L) beginning	61.3 ± 8.4	60.7 ± 3.8	0.83
Total protein (g/L) end	66.8 ± 5.6	63.7 ± 3.4	0.15
Triglyceride (mmol/L) beginning	0.19 ± 0.06	0.21 ± 0.09	0.62
Triglyceride (mmol/L) end	0.13 ± 0.04	0.14 ± 0.06	0.56
Urea (mmol/L) beginning	3.48 ± 1.37	3.48 ± 1.62	1.00
Urea (mmol/L) end	5.28 ± 1.60	4.21 ± 1.21	0.10
Ovulation rate	1.78 ± 0.81	1.69 ± 0.64	0.63
Fertility at first estrus (%)	58.8	68.6	0.49
Total fertility (%)	79.4	82.9	0.80
Reproductive productiveness at first estrus (average num. lambs born / ewe lambing)	1.54 ± 0.89	1.39 ± 0.81	0.38
Total reproductive productiveness (average num. lambs born / ewe lambing)	1.48 ± 0.57	1.39 ± 0.62	0.58
Reproductive wastage (%)	43.6 ± 0.45	44.1 ± 0.46	0.98

* Mean ± standard deviation. No significant difference existed between the measured variables ($p > 0.05$).

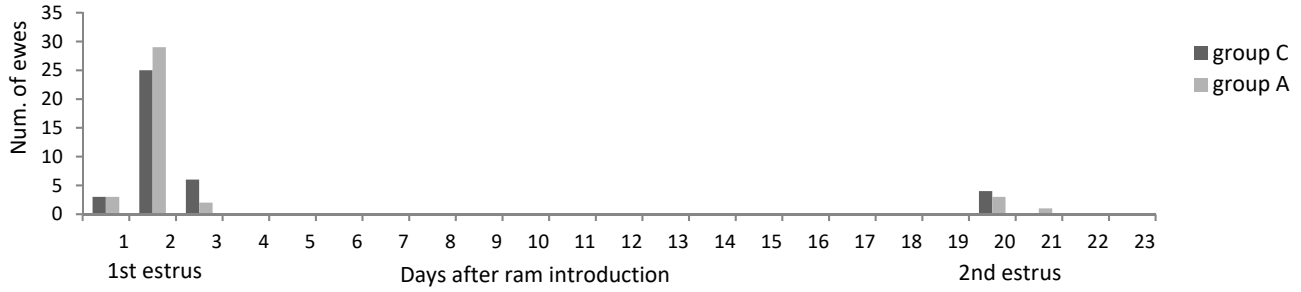


Figure 1: *Treatment effect on the occurrence of estrus in ewes supplemented daily (C) or every two days (A) after introduction of rams, at INRAT sheep farm, Tunisia*

Barbarine breed (Bedhiaf-Romdhani et al., 2013). Nevertheless, the levels of reproductive productiveness at both the induced estrus and after the entire mating period were lower than the average commonly reported for this strain of sheep (Bedhiaf-Romdhani et al., 2013). This could be explained by the rates of reproductive wastage recorded in this study, which remained much higher than those reported for local sheep breeds in Tunisia (Lassoued et al., 2004). There were no obvious causes for these high levels of reproductive wastage, but the low body condition of the animals in this experiment as well as the high temperatures in June were pointed out as main factors. In fact, Moberg (2000) suggests that if two or more stresses (nutrition, ambient temperature) occur simultaneously, the total cost may have a severe impact on biological functions such as reproduction. In addition, in sheep characterized by a high ovulation rate, early embryo mortality could be much higher than in non-prolific breeds (White et al., 1981).

Blood metabolites

The levels of blood metabolites for ewes in the two treatment groups are displayed in Table I. In our current experimental conditions, providing supplementary feed every two days did not affect blood-measured metabolites at the end of the treatment. Final concentrations of metabolite indicators of the energetic status (glucose, cholesterol and triglycerides) were similar in both groups as well as were the concentrations of metabolites indicating the protein status ($p > 0.05$). There was a trend showing glucose concentrations to be lower in animals supplemented every two days (1.93 ± 1.43 vs 2.46 ± 2.77 mmol/L) but this was not statistically significant. Many studies report that supplementary feeding influences the plasma glucose level, serum total protein, albumin and urea in ewes (Naqvi et al., 2013). Glucose is one of the most important metabolic substrates for ovaries and for adequate reproductive performance (Hess et al., 2005). Our results claim that adequate supplementation, even when its frequency is reduced to every two days, maintains ewes at a positive energy balance with no impact on their reproductive performance.

■ CONCLUSION

The data showed that offering a supplement of concentrate (energy and protein) every two days instead of each day to mature prolific Barbarine ewes raised in a semiarid environment yielded similar effects on animal performances (body weight and body condition score) and reproductive efficiency. These findings suggest that less frequent supplementation may contribute to an alternative management whereby supplementation costs might be substantially reduced without hampering reproductive performances.

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Résumé

Ben Khlil Z., Rekik M., Lassoued N. La complémentation des brebis Barbarines tous les deux jours durant la période de lutte n'affecte pas les performances reproductives comparativement à une complémentation quotidienne

Soixante-dix brebis Barbarines ont été réparties en deux lots homogènes et ont reçu 1200 g/tête/jour de foin complémenté avec 400 g/tête/jour de concentré, soit quotidiennement (lot C) soit un jour sur deux (lot A). La complémentation a duré trois semaines avant et trois semaines après la lutte. Le poids vif, la note d'état corporel et les métabolites sanguins ont été mesurés au début et à la fin de l'essai. La détection de l'œstrus a été effectuée deux fois par jour et l'activité ovarienne a été contrôlée par endoscopie 10 jours après l'apparition des œstrus. Il n'y a pas eu de différence significative ($p > 0,05$) entre les lots C et A respectivement pour le taux d'ovulation (1,78 ± 0,81 vs 1,69 ± 0,64), la fertilité au premier œstrus (58,8 % vs 68,6 %), la fertilité totale (79,4 % vs 82,9 %), la prolificité au premier œstrus (1,54 ± 0,89 vs 1,39 ± 0,81), la prolificité totale (1,48 vs 1,39) et les pertes reproductives (43,6 % vs 44,1 %). Les concentrations des métabolites sanguins ont été similaires ($p > 0,05$) dans les lots. Ces résultats suggèrent qu'une complémentation alimentaire moins fréquente pendant la période de lutte peut constituer une alternative qui réduit le coût de l'alimentation sans conséquence sur les performances reproductives des brebis prolifiques élevées dans des milieux arides.

Mots-clés *:* ovin, brebis Barbarine, complément alimentaire pour animaux, performance de reproduction, Tunisie

Resumen

Ben Khlil Z., Rekik M., Lassoued N. Suplementar ovejas Barbarine día de por medio alrededor de la monta no obstaculiza el rendimiento en comparación con la suplementación diaria

Se dividieron setenta ovejas Barbarine en dos grupos homogéneos y recibieron 1200 g/cabeza/día de heno, suplementado con 400 g/cabeza/día de concentrado, diariamente (grupo C) o día de por medio (grupo A). La suplementación duró tres semanas antes y tres semanas después del periodo de monta. Se midieron el peso vivo, la condición corporal y metabolitos sanguíneos al principio y al final del estudio. La detección de estro se llevó a cabo dos veces al día y la actividad de los ovarios se monitoreó por endoscopía 10 días después del inicio del estro. No hubo diferencia significativa ($p > 0,05$) entre los grupos C y A para la tasa de ovulación (1,78 ± 0,81 vs 1,69 ± 0,64), fertilidad al primer estro (58,8% vs 68,6%), fertilidad total (79,4% vs 82,9%), productividad reproductiva al primer estro (1,54 ± 0,89 vs 1,39 ± 0,81), productividad reproductiva total (1,48 ± 0,57 vs 1,39 ± 0,62), y pérdidas reproductivas (43,6% vs 44,1%), respectivamente. Las concentraciones de metabolitos sanguíneos fueron similares ($p > 0,05$) en ambos grupos. Estos resultados sugieren que una suplementación menos frecuente durante el periodo de monta puede ser una alternativa para reducir los costos de alimentación sin afectar el rendimiento reproductivo de ovejas prolíficas criadas en ambientes áridos.

Palabras clave*:* ovino, oveja Barbarine, suplemento de piensos, reproductividad, Túnez