Effect of Pre-Mating Water Deprivation on Ovarian Activity and on Reproductive Traits of Mature Barbarine Ewes during Summer Season

S. Khnissi, N. Lassoued, M. Rekik, and H. Ben Salem

Abstract—60 mature Barbarine ewes were used to study the effect of water deprivation on feed intake and reproductive traits. Animals were allocated to two groups of 30 animals each. Control ewes (C) had free access to water while deprived ewes (D) were watered every 3 days during 8 weeks in mating period. Feed and water intake were recorded daily for each animal. Body weight was measured every week. Rectal temperature was also measured every week of the trial on the 1st, 2nd and the 3rd day of water deprivation. Ovulation rate was determined by endoscopy 12 days after oestrus behaviour. Lambing rate and litter size were calculated. Body weight and feed intake were not affected ($P>0.05$) by water deprivation. However water intake increase in deprived ewes ($P<0.01$). Reproductive results showed that water deprivation did not affect significantly either the percentage of females in oestrus during the 3 days following ram introduction nor the return rate (80% vs 90% and 13% vs 10% respectively for control and water deprivation groups). Moreover ovulation rate, fertility and litter size were similar for both groups (110% vs 130%, 93.3% vs 100% and 103% vs 123% respectively for control and water deprivation groups). These results indicate the wide adaptation of Barbarine sheep for water deprivation as indicated by the absence of significant negative effects on reproductive performances.

Index Terms—Ewe, ovarian activity, reproductive traits, water deprivation.

I. INTRODUCTION

Prolonged dry season prevails in semi-arid regions where livestock graze far away from watering sites. In such areas, water is scarce particularly during the long hot and dry periods of the year and animal in the field often face heat stress and dehydration.

Breeds of ruminants inhabiting hot arid and desert areas have acquired various adaptation mechanisms that aid them in withstanding one week with little or even no water, water deficiency is proved to affect animals' physiological homeostasis leading to loss of body weight, low reproductive rates and a decreased resistance to diseases [1]. Many studies show a close relation between water intake and feed consumption [2].

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Several studies have demonstrated that heat stress can affect reproductive traits namely oestrus [3], ovulation rate [4] and embryonic mortality [5]. Nevertheless, the effect of water deprivation on ewe reproductive traits under hot conditions was not documented. The aim of this study is to investigate the effect of water deprivation during hot season, on oestrus, ovulation, and reproductive traits of mature Barbarine ewes in an attempt to further characterize the adaptive potential of this breed to dry areas [6].

II. MATERIAL AND METHODS

A. Location and Animals

The trial was carried out in the sheep research farm of BouRebia of the National Institute of Agricultural Research (INRAT). The station has a semi-arid climate, is located 25 km south of the town of Tunis 36°38' °N latitude, 10°07' East longitude. Average annual rainfall is 350 mm and represents the mean of 30 years. During the experimental period, the ambient temperature averaged 38 °C (35 °C min - 42 °C max). 60 adult ewes of the Barbarine breed were selected from the farm flock. Prior to the experiment, the animals were reared under similar conditions and were kept outside throughout the day.

B. Experimental Protocol

In early July, the animals were divided into 2 groups balanced for live weight and age. They were placed in individual boxes inside a barn, well ventilated and were continuously exposed to natural daylight. Animals were subjected to one of two treatments, treatment D (deprived) receiving water once every three days and Treatment C (control) receiving water daily. Ewes had access to tap water in the morning in buckets of 15 l capacity. Each of the 60 ewes was fed on a daily basis a diet composed of a mixture of straw (1 kg) and barley grains (0.4 kg) that was offered into 2 equal meals (at 08:00 and 19:00 h). The experiment lasted 32 days before and 28 days after introduction of rams. Therefore D animals were subjected to 8 successive cycles of water deprivation (3 consecutive days) and access to water (1 day) before male introduction. They were subjected to an adaptation period during which water deprivation was first imposed for 1 day, then for 2 days and thereafter for 3 consecutive days.

C. Measurements

Daily feed and water intake were determined throughout the experiment for 10 ewes of each group. Live weight was recorded every week before the distribution of the meal. Rectal temperature was measured every week of the trial on

the 1st, 2nd and the 3rd day of water deprivation using digital thermometers.

For the homogeneous reproductive cycles, Fluorogestone acetate sponges were used to synchronise and control estrous cycles. At sponges' withdrawal, teaser rams of the Barbarine breed were introduced to the ewes at a ratio of 1 ram for every 10 ewes. Sheep demonstrating oestrus were naturally mated to rams. The oestrous response, date of lambing and number of lambs born were recorded

Ovarian activity, assessed by the presence of corpora lutea and ovulation rate, was determined by endoscopy [7].

D. Statistical Analysis

The data obtained are presented as (means $\pm$ S.E). The statistical analysis was performed according to MIXED models procedure [8]. Source of variation included treatment with water deprivation and measurement time. The random variable was ewes within treatment. Comparisons of the proportions of ewes in reproductive traits were carried out using an X2 test

III. RESULTS

A. Food and Water Intake

The daily feed intake was not affected ($P>0.05$) by the treatment (Fig. 1). In fact, control and water deprivation ewes consumed respectively 868.491 ± 15.402 g and 852.804 ± 15.402 g of dry mater. Water consumption during the first hour of re-hydration was significantly ($p<0.01$) higher than that of controls or that consumed during hydration day. Indeed, in response to lack of water, water deprivation ewes increased their water intake until 10.983 ± 0.929 l against an average of 6.676 ± 0.929 l in the control ewes (Fig. 2).

Fig. 1. Mean ($\pm$ SE) daily feed intake (g) of control and water deprivation ewes.

Fig. 2. Mean ($\pm$ SE) of water intake in the rehydration day of each cycle of the trial on C and D ewes.

B. Live Body Weight

The evolution of the body weight of the ewes was similar in both groups in the first two weeks (5 cycles of water deprivation) of the experiment (Fig. 3). It was only after three weeks principally in the 6th cycle of water deprivation where there was a significant difference ($p<0.05$) in body weight between groups.

Fig. 3. Effect of water deprivation on the evolution of live weight of ewes in both groups during the pre-mating period.

C. Rectal Temperature

Rectal temperature increased ($p<0.05$) in ewes of the water deprivation group 39.32 ± 0.01 °C as compared with control ones 39.03 ± 0.01 °C (Table I).

TABLE I: MEANS ($\pm$ S.E.M.), MINIMUM AND MAXIMUM VALUES OF RECTAL TEMPERATURE (°C) OF CONTROL AND WATER DEPRIVED EWES

Parameters	Treatment		P
	(C) Daily watering	(D) Once per 3 days watering	
Average Tr	39.035 $\pm$ 0.015	39.325 $\pm$ 0.015	<0.001
Minimum	38.7	38.9	
Maximum	39.4	39.9	

Tr: rectal temperature

D. Oestrus, Ovulation Rate, Fertility, Litter Size and Embryonic Mortality

Fig. 4. The effect of water deprivation stress on the distribution of oestrus behaviour in the 3 days after the introduction of rams.

The percent of ewes that showed oestrus behaviour was shown in table II. According to treatment, 89% of deprived ewes against 76% showed oestrous behaviour in the first 2 days after the introduction of rams (Fig. 4), but this difference between groups was not statistically significant ($P>0.05$). In the other hand the percentage of return to oestrus

is similar between the groups. (13% vs 10% in C and D ewes respectively). The effect of water deprivation on ovulation was presented in Table III. Ovulation rate was 130% in D group vs 110% in C group and the number of double ovulation was respectively 9 vs 3 ($P>0.05$).

Although deprived ewes exhibited improved lambing rates and litter size as compared with the control, this did not attain significance. Fertility was 100% vs 93% respectively in water deprivation and control group. Similarly, litter size was 123% vs 103% (Table. IV).

TABLE II: THE EFFECT OF WATER DEPRIVATION ON THE OESTRUS BEHAVIOUR

Parameters	Treatment		P
	(C) Daily watering	(D) Once per 3 days watering	
Estrus (%)	80	90	>0.05
Rate of return of oestrus (%)	13	10	>0.05

TABLE III: THE EFFECT OF WATER DEPRIVATION ON OVULATION RATE, NUMBER OF EWES WITH SINGLE OR DOUBLE OVULATIONS

Parameters	Treatment		P
	Daily watering (C)	Once per 3 days watering (D)	
Single ovulation	27	21	>0.05
Double ovulations	3	9	>0.05
Ovulation rate (%)	110	130	>0.05

TABLE IV: THE EFFECT OF WATER DEPRIVATION ON FERTILITY, LITTER SIZE AND EMBRYONIC MORTALITY

Parameters	Treatment		P
	(C) Daily watering	(D) Once per 3 days watering	
Fertility (%)	93.33	100	>0.05
Litter size (%)	103	123	>0.05
Embryonic mortality (%)	3	5	>0.05

IV. DISCUSSION

Climate change is affecting more and more water reserves especially in arid zones where unavailability of water in addition to high temperatures adversely affects her productivity in different levels. Barbarine breed is known by their attitude of adaptation to dry areas conditions. Water-deprived ewes drank much more at each drinking time than control ewes. Our results agree with previous work [9]. The rumen is known to be a water reservoir that can store a large volume of water taken in at the end of dehydration period. In fact, 3 days of water deprivation can stimulate more water consumption in order to compensate for the high water deficiency caused by water losses. Studies on dehydrated sheep have shown that they were able to drink up to 23% of their dehydrated body weights [10]. This

depends on the degree of body weight loss as well as the volume of the rumen, which could accommodate the volume of water ingested on rehydration.

Dehydration tolerance can be assessed essentially by the rate of body weight changes when water is scarce. During the trial, water deprivation caused a fall in body weight that began from the third week of treatment and continued till the end of deprivation period. This result was obtained without any drop of feed intake. However, most of previous works showed that feed consumption is strongly related to water intake [2], where sheep reduced their voluntary feed intake under 3-4 days intermittent watering regime [1]. Specially when it is associated with heat stress [11]. In such cases, it is difficult to differentiate if loss of body weight reflects changes in feed intake or changes in body water. Many authors showed that most of the live weight losses during dehydration were accounted for body water loss in small ruminants [12] result of a cortisol induced diuresis in stressed animals by water scarce [12].

Another consequence of dehydration is thermoregulation. In our work, rectal temperature value of the water-deprived ewes remained above that of the control ones. This is agree with previous works where temporary hyperthermia is often reported in dehydrated sheep [13]. Hyperthermia is one of mechanisms that allow animals to avoid excessive water expenditure during the hot part of the day especially as our study was conducted during the warmer months of the year. On the other side, authors reported that sheep are thermostable even during dehydration [14].

To our knowledge, studies on the effect of water deprivation on reproductive traits in sheep are very scarce. However, the effects of stressors like nutrition and ambient temperature on reproductive activity are reported in sheep [15].

Estrus behaviour in sheep is a part of a continuum of interaction between the sexes. The incidence of oestrus and receptivity of ewes are important factors that seem to be especially sensitive to stress [15]. However, in our study we didn't show that water deprivation affects significantly oestrus, despite that it seems that the number of water deprivation ewes come in heat is higher than in the control group.

The other reproductive parameters that reported in this study didn't show any significant differences between groups. However, ovulation rate, fertility and litter size were slightly higher in water deprived ewes than in the control ones. Despite this result was not statistically significant, it should be taken into consideration. Further studies are needed to deepen this effect since some authors reported a variation of some metabolites in serum that could explain a difference like increase in serum protein [13] due to the decreased blood volume.

V. CONCLUSION

This study showed that it is possible to conduct a mating during the hot season with once per 3 days watering regime, without affecting reproductive traits in Barbarine ewes. Water economy appears to be important under the studied water limitation that demonstrates the adaptation of Barbarine.

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