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The Oestrous Behavior of the Karayaka Sheep in Turkey

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Abstract: In order to verify the estrus activity of the Karayaka ewes reared under natural conditions of the Black Sea Region of Turkey throughout year, ten, 3 years-old Karayaka ewes with an average weight of 46±7.9 kg and with two lambing record, were used. In this experiment four climatic seasons were considered; winter, spring, summer and autumn. Behavioral oestrus was monitored twice a day (7: 00 and 15: 00) during all the experiment by using two teasers rams. The oestrus cycles were quantified within each season and classified as short (≤14 days), normal (15-20 days) and long (or anoestrus, ≥21 days). The percentage of ewes in oestrus was higher ($p<0.05$) in the autumn than in the winter and summer seasons and the percentage never exceeded 40% in each season. The minimum length of short cycle was 11 days while maximum length of anoestrus was 87 days and the average length of normal cycle was 17.3±1.06. During the experiment, there were 11.9% short cycles, 35.8% normal cycles and 52.3% anoestrus. The percentages of abnormal cycles (short and anoestrus), in relation to total cycles monitored in each season were 87.4, 88.5, 90.9 and 35.5% for winter, spring, summer and autumn, respectively. It can be concluded that Karayaka ewes maintained on rangeland show a low seasonality for oestrus behavior. Thus, in this oestrus pattern, mating may occur from late spring through to late autumn taking into account demands for slaughter lambs and/or feeding of lambs in rangeland.

Key words: Estrus, Karayaka ewe, reproduction, seasonality, sheep

INTRODUCTION

In recent years, animal production systems have changed dramatically. This has lead to two alternative strategies which can be defined schematically as (a) intensive systems in which farm animals are expected to be less dependent on their environment and (b) extensive systems in which animals are subjected to the natural variations of their environment. These rapid changes have meant the control of seasonal production and reproduction in farm animals have become major research goals (Chemineau *et al*., 2007). The seasonality of breeding activity in sheep represents an important constraint in the breeding program of commercial flocks. In a majority of seasonal breeding species, including sheep, induced ovulations are generally required if farmers want to fertilize females for a specific season, out of the breeding season (Olfaz, 1992; Banos and Avdi, 2003; Chemineau *et al*., 2007).

Seasonality of breeding is a major impediment to improvement of reproductive efficiency in sheep (Al-Shorepy and Notter, 1997). Therefore, the control of seasonal production

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and reproduction in sheep without hormonal treatments is dependent on genotype (Chemineau *et al*., 2007), potential reproductive performance (Abecia *et al*., 1997), reproduction seasonality (Galina *et al*., 1996; Arroyo *et al*., 2007) of animals and the nature of the ewe's long and/or short-term nutritional regimens (Haddad *et al*., 2005; Ocak *et al*., 2006) and climatic conditions (Chemineau *et al*., 2007). Furthermore, the response to hormonal treatment in small ruminants is variable and depends on many factors (Ramon-Ugalde *et al*., 2008). Seasonality of ovulatory activity is observed in European sheep whereas tropical breeds show almost continuous ovulatory activity (Lindsay, 1996). In sheep, seasonality is under photoperiodic control. In experimental conditions, long days inhibit and short days stimulate sexual activity because alterations in reproductive activity are associated with alterations in both the timing and duration of gonadal activity. In the review of Chemineau *et al*. (2007), it has been noted that the various breeds may express variable degrees of seasonality. Texel, Soay and Iceland ewes are highly seasonal while Merinos and Manchega ewes present more discrete expression of seasonality. The breeds raised in more southern areas, especially in the subtropics and the tropics generally present low seasonality or cycle throughout the year (Salloum and Claus, 2005; Aguirre *et al*., 2007; Chemineau *et al*., 2007). Ile-de-France ewes behave in the same way but some females show isolated ovulations without associated behavior during the anoestrous season (Chemineau *et al*., 1992). Chu *et al*. (2006) noted that Small Tail Han and Hu ewes are non-seasonal estrous breeds while Dorset, Suffolk and German Mutton Merino ewes are seasonal estrous breeds.

Karayaka sheep, widely raised under adverse conditions in the Black Sea Region of Turkey, is a native breed. Slaughter lambs of this breed are in demand throughout the year because Karayaka is one of the most important breed among the native breeds with high meat quality and also adaptation ability (Olfaz *et al*., 2005). There is no clear policy for evaluating this genotype and appreciation of their potential. Thus emphasis has been on the importation of specialized breeds, such as the Sakiz, German Black Headed Mutton and Hampshire Down, which are maintained in their genetic purity or used in crossings with this breed to improve milk and meat production (Olfaz, 1997). The Karayaka breed is considered to be of low fecundity (0.66) and small breed (approximately 45 kg). They are usually maintained on rangeland without roughage or compound feed supplementation during the day from weaning to breeding season (approximately 4-5 months). In practice, the annual breeding season begins in early autumn in Karayaka ewes and ends in early spring, resulting in a marked seasonality in birth dates of lambs.

Mediterranean breeds are adapted to reproductive strategies (Banos and Avdi, 2003) because of their reduced reproductive seasonality and their response to photoperiod can be modulated by other environmental (nutrition) or social (male effect or permanent contact ewes-rams) factors (Lindsay, 1996). Indeed, Olfaz (1992) reported that hormonal-induced Karayaka ewes can be used for lambing for a specific season, out of breeding season and also Ocak *et al*. (2006) showed that the reproductive performance of Karayaka ewes can be improved by nutritional regimens around the time of mating, confirming the reproductively potential ability of this breed. Unfortunately, there is incomplete knowledge of the changes of oestrus activities of the Karayaka ewes throughout year, which can be an interesting trait of this breed for farmers who want to organize the breeding season of their flock without expensive hormonal treatments. The objective of the present study was, therefore, to verify the estrous activity of Karayaka ewes, reared extensively during four different seasons. In sheep, some reproductive traits including the onset, offset and duration of the breeding season were found heritable, therefore becoming candidates for the genetic selection and the

control of seasonal production and reproduction (Al-Shorepy and Notter, 1997). However, these traits are quite difficult to measure at farm level because of their strong link with the female production cycle. An alternative approach would be to use more indirect traits (Hanocq *et al*., 1999) such as the presence or absence and interval of oestrus activity during each season or month, a trait found to be heritable in Karayaka ewes in the present study.

MATERIAL AND METHODS

The experiment was conducted at the experimental farm of the Ondokuz Mayis University, Samsun, Turkey, which is located at 41° 21'40" N and 36° 11'01" E under natural day length conditions during 2000-2003 successive three years. The variation of photoperiod in this location is approximately 4: 23 h between the solstices of the summer and winter. In the region where the experiment was carried out, February was the coldest month with a mean temperature of 6.2°C, minimum of -6.8°C, maximum of 26.2°C and relative humidity of 70%. For the hottest month, August, the corresponding values were 23.5, 8.0, 33.0ºC and 74%, respectively. Daily average maximum temperatures exceeded 35°C during April through September. Average maximum temperatures were less than 30°C during October through March. Relative humidity was lowest in December (67.3%) and increased to 80.3% in May (Soydan *et al*., 2008). In this experiment four climatic seasons of the year were considered as: winter (December to February), spring (March to May), summer (June to August) and autumn (September to November). Average maximum, minimum and daily temperatures on a monthly basis and average relative humidity were calculated during the experiment. Climatic data were obtained from Turkish State Meteorological Service (TSMS 2007; Samsun, Turkey) and also the daily environmental temperature (mean, maximum and minimum) in the experimental farm was recorded.

Ten, 3 years-old Karayaka ewes with an average weight of 46±7.9 kg and with two lambing record, were used in the study. In order to verify any reproductive disorder, manual examinations were performed monthly during the experiment. The animals were grazed between 09:00 and 16:00 h on rangeland during dry season and were housed as a group for the rest of the day and were fed grass hay. During the rainy season animals were fed only a full nutrient total mixed ration. In the morning, the ewes received grass hay *ad libitum*, while in the afternoon, they were supplemented with commercial concentrate (18% of crude protein). The animals had free access to water and to mineral salt.

All ewes were isolated from rams. However, oestrus behavior was monitored twice daily (7:00 and 15:00) using two teasers rams over 3 years. Immobilization of the female when mounted by the male was considered to be a sign of occurrence of oestrus. The number of oestrus cycles, as well as the length, was recorded during each month and season. The estrous cycles were classified as short (≤14 days) and normal (15 to 20 days) and also long (≥21 days) based on the standard deviation of the mean estrous cycles in practice for this breed (Olfaz, 1992). In this study, duration of anestrous was evaluated as the long cycles.

Because the number of ewes (10 ewes) used was little, the experiment was replicated over three years. Since the interval of oestrus and the proportion of ewes in oestrus were similar among years (data not shown), the pooled data for three years were analyzed. The data oflength of estrous were analyzed after transformation to homogenize variance (log(x+1)). The interval of oestrus per season was analyzed according to the ANOVA model, using the ONEWAY procedure of the SPSS (1999). The proportion of ewes in oestrus per season and the percentage of ewes experiencing at least one oestrus per month were analyzed by χ^2. Differences were taken as statistically significant at $p<0.05$.

RESULTS

The average monthly temperature (°C), rainfall (mm) and humidity (%) during the experimental period was similar (Fig. 1) to the mean monthly value for 28 years (TSMS, 2007) in the region where the experiment was carried out, indicating that the experimental period was representative of the climate for this area.

A larger percentage of ewes in oestrus was observed during the autumn (39.9%) season ($p<0.05$) compared to the winter (12.7%) and summer (22.5%) seasons, but not spring (24.9%) season (Fig. 2). The percentage of ewes experiencing at least one oestrus per month dramatically decreased from October (80%) to February (20%) and also from April (100%) to July (40, 60 and 50%, respectively (Fig. 3). There are a greater percentage of ewes showing at least one oestrus per month on April (100%), August (80%), September (90%) and October (80%) for the three years (Fig. 3). Therefore, a greater proportion of ewes showed anestrous in February and May (80 and 60%, respectively, Fig. 3). While a low proportion of Karayaka ewes (20%, 2 of 10) were continuously heating throughout the year for three

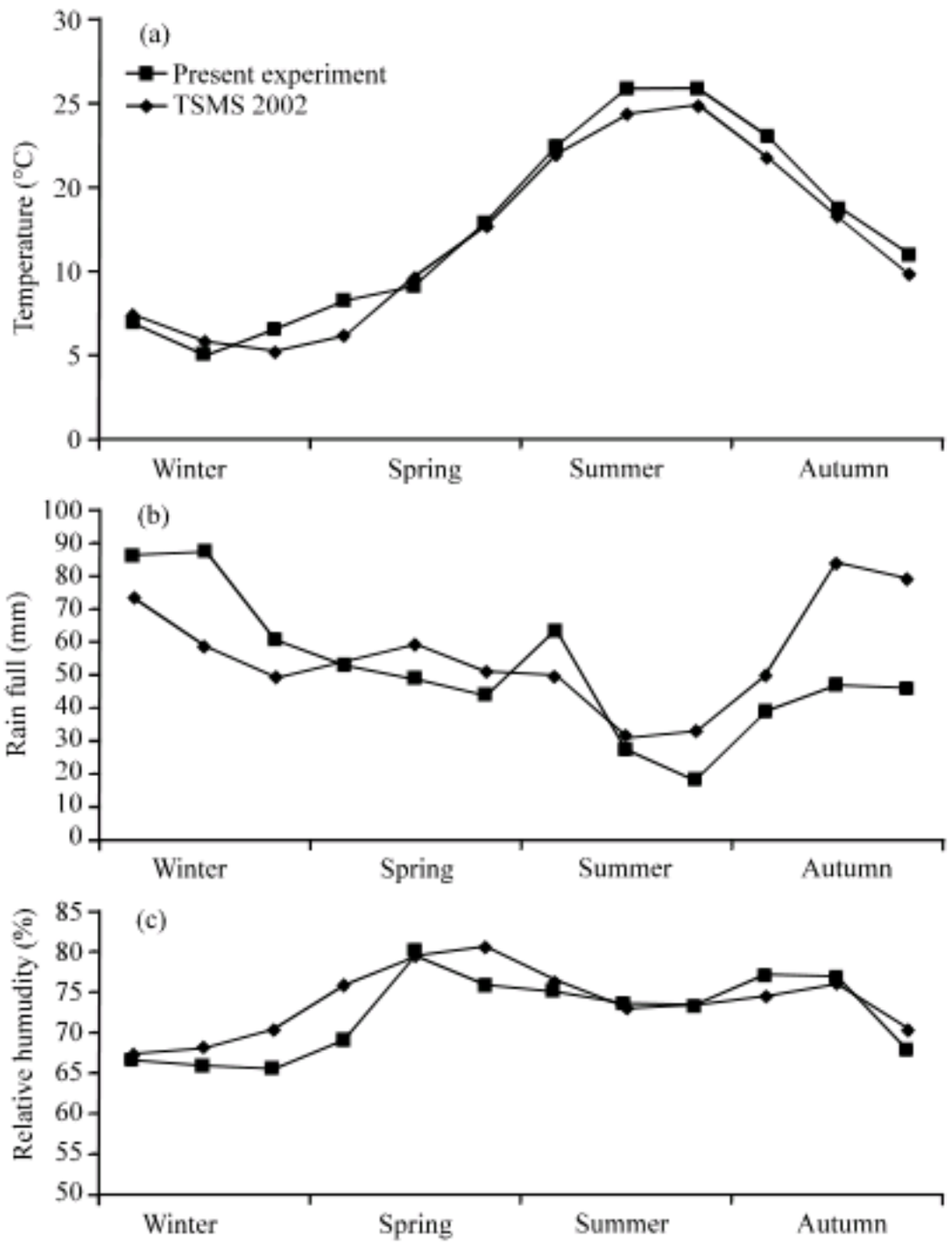

Fig. 1: (a) Average monthly temperature, (b) rainfall and (c) humidity during the winter, spring, summer and autumn seasons from 2000 to 2002 and from 1974 to 2002

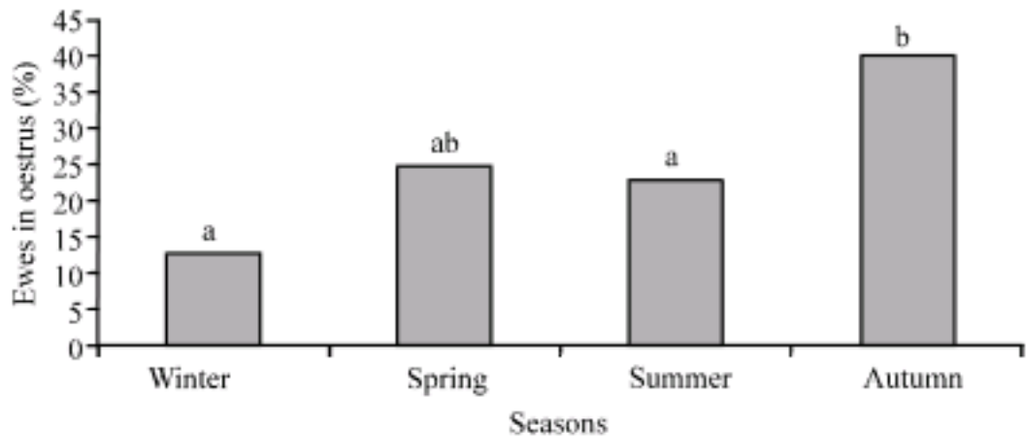

Fig. 2: Mean percentage of Karayaka ewes in oestrus during the spring, summer, autumn and winter season (Different letters among seasons indicate a difference at $p<0.05$)

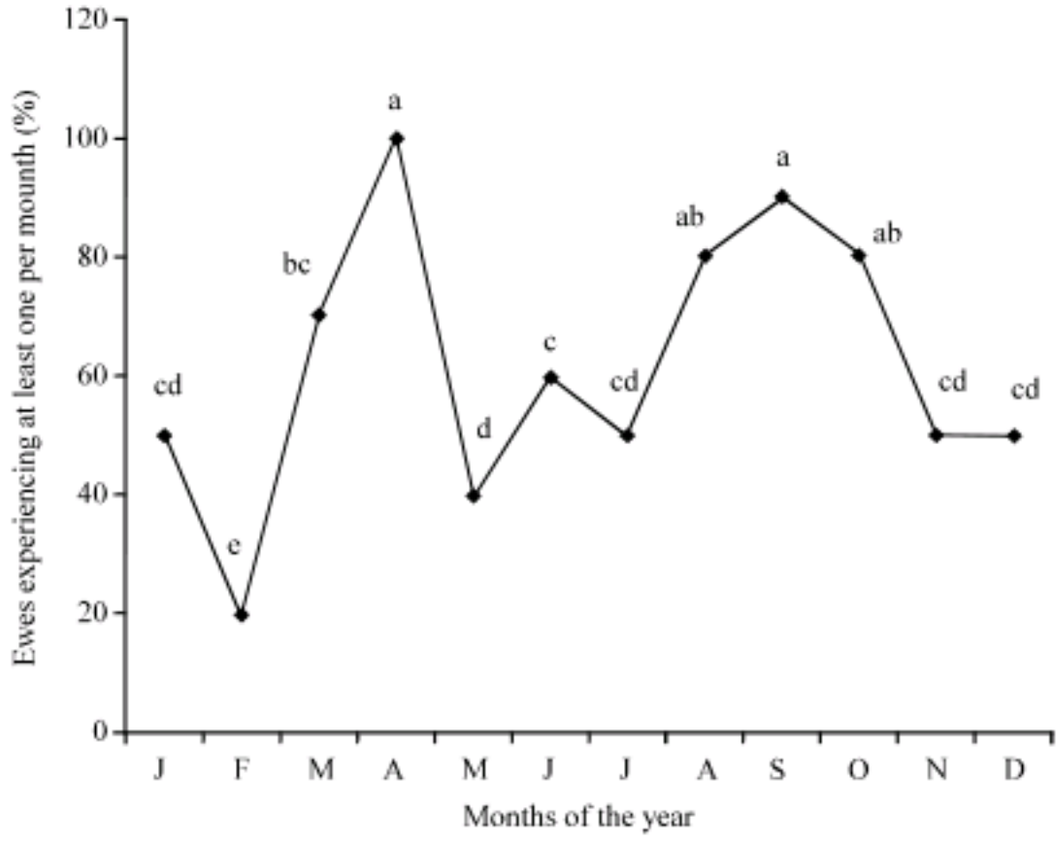

Fig. 3: The percentage of ewes experiencing at least one ovulation per month. (Different letters among month indicate significant difference at $p<0.05$)

consecutive years, regardless of natural changes in photoperiod, 3 of 10 ewes (%30) showed periods of anestrous (>65 days) from December to February or from May to July.

Among the seasons, there were not differences in the percentages of normal and long cycles (Fig. 4), while the mean length of short cycle was found significantly different among the seasons (Table 1). A lower percentage of anestrous was observed in the autumn season ($p<0.05$) when compared to the winter and spring seasons. Within the winter, spring and summer season, there were lower percentages of the short and normal cycles compared to the long cycles ($p<0.05$), while within the autumn season there were higher percentages of normal cycles compared to the short and long cycles ($p<0.05$, Fig. 4). The percentage of abnormal cycles (short and long cycles), in relation to total cycles monitored in each season were 87.4, 88.5, 90.9 and 35.5% for winter, spring, summer and autumn, respectively. The mean length of normal cycles was 17.3±1.06 days. The minimum length of short cycle was 11 days and maximum of long cycle (anoestrus) was 87 days. The mean lengths of short cycle monitored in spring and autumn seasons were longer than that monitored in winter and summer ($p<0.05$). The mean lengths of normal oestrus cycle monitored in each season were

Table 1: Length of oestrus cycles (days) in the different seasons

Cycles	Winter	Spring	Summer	Autumn	SEM
Short	0.0^{b}	11.5^{a}	0.0^{b}	13.2^{a}	0.94
Normal	17.1	17.5	18.0	16.7	1.06
Long cycles (Anoestrus)	30.1	32.7	43.6	26.0	15.45

Means within a row lacking a common superscript are different ($p<0.05$).SEM: Standard error of the mean

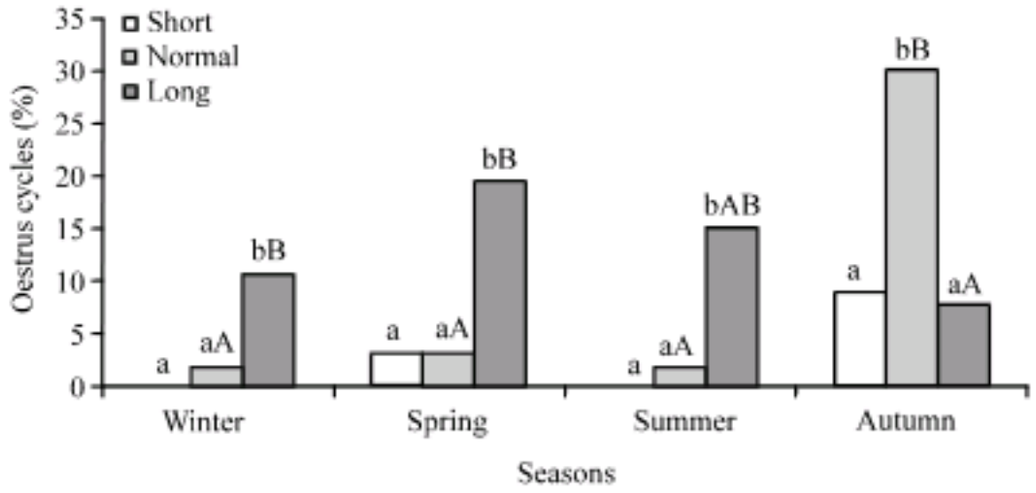

Fig. 4: Mean percentage of short, normal and long estrous cycles of Karayaka ewes during the winter, spring, summer and autumn season. Different letters (a, b) among types of cycles within seasons and different letters (A, B) for each type of cycle among seasons indicate significant difference ($p<0.05$)

similar for winter, spring, summer and autumn, respectively. The percentage of normal cycles was higher ($p<0.05$) in the autumn when compared to the other seasons (Fig. 4).

DISCUSSION

The results of the present study indicate that Karayaka ewes maintained on rangeland show a low seasonality for oestrus behavior and thus in this oestrus pattern, most mating occur from spring through to late autumn. These results confirm that the breeding season of ewes is a succession of 16-18 day estrous cycles, which usually begins in the late summer or early autumn and ends in the late winter or early spring (Forcada and Abecia, 2006). In the natural breeding season of this breed, i.e., at the early autumn, Ocak *et al*. (2006) observed normal cycles with a mean (±SEM) length of 17.7±0.6 days, which it is similar to that observed in our experiment. It is cognoscible that some scientific articles on the oestrous behavior of sheep contain also such physiological data as: oestradiol (E2) and progesterone (P4) and Luteinizing Hormone (LH) and the major genes which effect on ovulation rate. Unfortunately, these sexual hormones and genes were not investigated in the present study due to preliminary study.

In the Black Sea Region of Turkey during the rainy season there is abundance of forage, while during the dry season, the forage is scarce and fibrous and, consequently, of low quality (Ocak *et al*., 2006; Ayan and Acar, 2008). Because adverse conditions of pasture and rangeland (Martin *et al*., 2002; Otal *et al*., 2008), which results in a decrease in both nutrient intake and digestibility of rangeland by ewes and, consequently, a decrease of the body weight (Molle *et al*., 1997), coincide with the time of breeding of ewes, the reproductive performances of animals may be very low. This hypothesis confirmed by the fact that the results of Ocak *et al*. (2006), who reported that reproductive performance of Karayaka ewes can be improved by nutritional regimens around the season of their natural breeding, i.e., at the early autumn. However, in the present experiment, the animals were in an extensive

system to verify the oestrus activity of Karayaka ewes grazed on rangeland during four different seasons. Indeed, grass growth seemed to be the key factor influencing sexual activity in ewes and rearing management had a statistical effect on interval per lambing (Galina *et al*., 1996). Although, the body weight of Karayaka ewes was not determent, oestrus activity of this breed may not be affected the body weight due to the fact that there was no significant effect of body weight on estrous cycles (Forcada and Abecia, 2006; Arroyo *et al*., 2007; Farshad *et al*., 2008).

According to the results of the present study, there might exist three different types of Karayaka ewes. One type is the animals having a low threshold for sensitivity to the subtle changes of tropical photoperiod thus those with a regular anestrous season from 1 year to the next. A second group is the ewes with a significant threshold for sensitivity to variations of day length, thus these ewes are insensible to the typical daylight of 41°N and continue to have estrous cycles throughout the year under these conditions. Seasonality of the reproductive activity in sheep is a general phenomenon for mid and high-latitude breeds (Rosa and Bryant, 2003). The third group of ewes with an extremely high threshold to being insensitive to photoperiodic changes, continue to have estrous cycles throughout the year even under annual photoperiodic changes typical of higher latitudes. In contrast, under controlled nutrition and in absence of males, it has not been reported whether all Karayaka ewes had a defined anestrous. Therefore, the differences in the percentage of ewes in oestrus were remained to explain whether the females are insensitive to photoperiod or photoperiodic changes are too small to impact the physiology for the females.

Under natural conditions of temperate countries, sheep (Malpaux *et al*., 2001) probably have an endogenous rhythm that is synchronized by photoperiod such that breeding occurs during autumn/winter and an-ovulation (anestrous) occurs during spring/summer. Most sheep breeds raised in the Mediterranean basin show seasonality in their reproductive cycle (Banos and Avdi, 2003), confirming the results of the present study. Indeed, our results indicate that oestrus behavior and/or ovulatory activity in this breed usually start between late spring and the beginning of summer and late winter is normally an anoestrous period, characterized by low frequency of spontaneous (non-induced) ovulatory activity. Local breeds of sheep (Mahieu *et al*., 1989) under their native tropical conditions are either non-seasonal breeders or exhibit only a weak seasonality of reproduction. The females of these breeds ovulate and exhibit oestrus almost the whole year round, even though short periods of an-ovulation and anestrous are detected in some females. The higher percentage in the autumn than in the winter and summer seasons may be related that their response to photoperiod can be modulated by other environmental (nutrition) or social (male effect or permanent contact ewes-rams) factors (Lindsay, 1996). Nutrition has a smaller influence on sexual activity than on ovulation rate. Furthermore, nutrition seems to have a moderate effect on the seasonality of reproduction in Mediterranean breeds of sheep; however, the response can vary depending on the season (Forcada and Abecia, 2006). Evidently, only severe malnutrition can significantly extend the length of the seasonal anoestrous period, which is mainly attributed to an earlier end of the reproductive season. However, in several Mediterranean breeds of sheep, improving nutrition after weaning has consistently failed to advance the onset of sexual activity following lambing in seasonal anoestrus (Abecia *et al*., 1993; Forcada *et al*., 1995). The fact that the 20% of ewes in the contrition of the present study were continuously heating throughout the year for three consecutive years, regardless of natural changes in photoperiod suggests that further research is required

on annual oestrus activity in Karayaka ewes under natural environmental conditions, controlled feeding and in absence of males.

Seasonal anoestrus is the main mechanism which favors birth in spring when climatic conditions are optimal for the survival of offspring (Salloum and Claus, 2005). Additionally some species have developed mechanisms to ensure birth synchrony which is primarily mediated by male pheromones leading to mating synchrony (Santiago-Moreno *et al*., 2000; Rosa and Bryant, 2003). On the other hand, use of males for estrous detection as well as factors such as amount of nutritional intake, variations in environmental temperature or relative humidity other than photoperiod could be responsible for the seasonal reproductive changes (Rosa and Bryant, 2002). Domesticated breeds of sheep generally are influenced by these mechanisms to a varying degree depending on the breed. In the study of Salloum and Claus (2005) has been noted that Soay and Iceland sheep are regarded to be highly seasonal, whereas Merinos are less influenced. Therefore, the results with respect to the percentage of ewes in oestrus in each season indicate that Karayaka ewes were less influenced by these mechanisms.

Despite the high percentage of oestrus observed during the spring season, this fact cannot be related to a better reproductive activity, because during this season it was observed the largest percentage of legume in the rangeland, mainly of estrogenic plants or the sudden appearance of green feed (Aydin and Uzun, 2005). Thus, we cannot translate the high percentage of oestrus verified in the spring season as a parameter of good fertility nor of good reproductive performance. On the other hand, the percentage of ewes in oestrus and length of oestrus is critical to improving conception rates. Therefore, the similarity between the spring and autumn season in terms of the percentage of ewes in oestrus and the length of short oestrus indicate that during these seasons a good reproductive performance can be obtained.

CONCLUSION

It can be concluded from the results of this study that Karayaka ewes maintained on rangeland show a low seasonality for oestrus behavior and thus, in this oestrus pattern, most mating occur from late spring through to autumn, taking into account demands for slaughter lambs and/or feeding of lambs in rangeland. Therefore, identification of continuous oestrus Karayaka ewes may be the first step for developing a selection program against seasonality to increase lambing frequency. Thus, ewe-breeding programs under extensive management could benefit from more extensive use of Karayaka ewes due to the minimal seasonal effects on reproduction. However, the data obtained from in the present study are a kind of preliminary data and more research is required to make any meaningful conclusion on the seasonality of breeding and is required to determine factors influencing the quality of sexual activity and reproductive performance in this breed.

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