Reproductive performance of Karakul ewes following different oestrous synchronisation treatments outside the natural breeding season

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Abstract

This study was designed to evaluate the efficiency of five different hormonal treatments of oestrous synchronization in Karakul ewes reared in southern Iran. During mid- to late spring, (outside the natural breeding season), 180 Karakul ewes were stratified based on age and body weight and then randomly allocated to six groups (n = 30/group). The oestrous cycles of the ewes in each group were synchronized using one of the following hormonal treatments: T1 - intramuscular (im) administration of 20 mg progesterone acetate in oil every second day for a 12-day period and an im administration of 500 IU equine chorionic gonadotrophin (eCG) on day 12; T2 - insertion of a controlled intravaginal drug releasing device (CIDR) containing 0.3 g progesterone for 12 days; T3 - administrating an intravaginal sponge containing 60 mg medroxyprogesterone acetate (MAP) for 12 days; T4 - a double injection (im) of 10 mg prostaglandin $F_2\alpha$ nine days apart; T5 - a double injection (im) of 10 mg prostaglandin $F_2\alpha$ nine days apart plus an im injection of 500 IU eCG on the day of the second prostaglandin $F_2\alpha$ administration; T6 - control group. The ewes in Treatments 2 and 3 were intramuscularly injected with a 500 IU eCG at CIDR or sponge withdraw. Twenty-four hours after the last hormonal treatment, three fertile Karakul rams were introduced to the ewes in each experimental group and remained there for five days for oestrous detection and mating. Significant differences in oestrous response, number of ewes that lambed within the 152 ± 7 day period, fecundity and fertility rate were recorded between treatment groups. The oestrous response was comparable in Treatments 2 (93%) and 3 (100%), and significantly higher than the other treatments (T1 = 80; T4 = 37; T5 = 30 and T6 = 20%). The highest and the lowest number of ewes that lambed within 152 ± 7 days were 27 (90%) in Treatments 3 and 4 and 13% in Treatments 4 and 5, respectively. The highest recorded fecundity rate was 133% in Treatment 3 and the lowest, 75% in Treatment 4. Furthermore, the fertility rate was 90% in Treatment 3 that was significantly higher than in Treatments 4 (36%) and 5 (44%). The results of the present study indicated that oestrous synchronisation with progestagens plus eCG induced a synchronized oestrus in a higher percentage of Iranian fat-tailed Karakul ewes than prostaglandin $F_2\alpha$ (with or without eCG) outside the breeding season. Furthermore, the administration of an impregnated intravaginal sponge for a 12-day period plus a dose of 500 IU eCG resulted in higher fertility, fecundity and lambing rates compared to the other hormonal treatments considered.

Keywords: Karakul ewes, oestrous synchronization, reproductive performance
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Introduction

The Karakul sheep is a fat-tailed breed, and very common to the Asian and African continents. The Karakul was originally categorized as a desert animal that stores fat in its tail to be mobilized during periods of food scarcity. Pelts of Karakul lambs are historically referred to as "Persian lamb", and these sheep are also sources of milk, meat, tallow and fibre. The Karakul is a medium-sized sheep, but it differs distinctively from many other breeds with regard to body conformation. The Karakul has an extended breeding season, making it possible to produce three lamb crops every two years. Single lambs are the rule, though twins are not uncommon (Sefidbakht *et al*., 1978; Nsoso *et al*., 2003). The Karakul ram has been shown to have the capability to be used for mating all year round (Kafi *et al*., 2004).

Oestrous synchronization is a valuable management tool that has been employed successfully in enhancing reproductive efficiency, particularly in cows, ewes and does (Kusina *et al*., 2000). Oestrous synchronization is applied effectively in assisted reproductive techniques such as artificial insemination and

embryo transfer in small ruminants (Godfrey *et al.*, 1997). In addition, the use of oestrous synchronization creates the opportunity for timed breeding and lambing. This in turn results in taking advantages of seasonal variation of forage availability, photoperiod, labour resources and market demands. Oestrous synchronization in small ruminants is achieved either by reducing the length of the luteal phase of the oestrous cycle with prostaglandin $F_2\alpha$ or by artificially extending it with exogenous progesterone or potent progestagens (Evans & Maxwell, 1987; Jainudeen *et al.*, 2000; Kusina *et al.*, 2000). Since the prostaglandin method is limited to the breeding season (active *corpus luteum)*, different protocols for synchronization of oestrus using either progesterone or progestagens have been introduced (Hamra *et al*., 1989; Wheaton *et al*., 1993; Godfrey *et al.*, 1997; Rosado *et al*., 1998; Boscos *et al*., 2002).

Despite the remarkable contribution of the Karakul to the economy in the Middle East, little information is available on the efficiency of the different hormonal treatments for inducing and synchronizing oestrus in this fat-tailed sheep breed. Forage availability and market demand being the two main determining factors for time of breeding (Gordon, 1997). In southern Iran farmers tend to breed Karakul ewes outside the breeding season (mid- to late spring) when pastures are in good condition. Furthermore, breeding of ewes at this time of the year results in a shorter generation interval due to a reduction in their age at puberty (Gordon, 1997). The present study was designed to evaluate the efficiency of five different hormonal treatments for oestrous synchronization in Karakul ewes outside the natural breeding season in southern Iran.

Materials and Methods

This study was conducted during the last month of spring (outside the breeding season) in 2000 at a research farm in the Fars Province, southern Iran. The research unit is located at an altitude of 1288 m and 28° 54′ and 52° 43′ latitude and longitude, respectively. The average annual temperature, humidity and rainfall at this location are 17.3 °C, 58% and 186 mm, respectively.

One hundred and eighty Karakul ewes (3 to 4 years of age) with a normal reproductive history and 40 to 45 kg body weight were used in this study. At the beginning of the study females were stratified based on age and live body weight, and then randomly allocated within groups to six treatment groups (30 ewes/group). The experiment was performed in three replicates with 10 ewes in each replicate. Before the onset of the study and after mating, ewes grazed natural pastures. A mineral supplement and water were offered *ad libitum*. During the study animals were housed in pens of *ca.* 25 × 4 m (10 ewes/pen) that allowed free access to water and food in the form of hay and dried wheat chaff.

The oestrous cycles of the ewes in each group were synchronized using one of the following hormonal treatments: Treatment 1 - intramuscular (im) injection of 20 mg progesterone acetate in oil (Progesterone, Aboureihan, Iran) every second day for a 12-day period and an im injection of 500 IU equine chorionic gonadotrophin (eCG) (Folligon, Intervet, Holland) on day 12; Treatment 2 - insertion of an intravaginal drug releasing device (CIDR) containing 0.3 g progesterone (InterAg, New Zealand) for 12 days followed by an im injection of 500 IU eCG at CIDR removal; Treatment 3 - administration of an intravaginal sponge containing 60 mg medroxyprogesterone acetate (MAP) (Veramix, Pharmacia &Upjohn, Greece) for 12 days and an im injection of 500 IU eCG at sponge removal; Treatment 4 - a double injection of 10 mg prostaglandin $F_2\alpha$ (Lutalyse, Upjohn, Belgium) nine days apart; Treatment 5 - a double injection of 10 mg prostaglandin $F_2\alpha$ nine days apart plus an im injection of 500 IU eCG on the day of the second prostaglandin $F_2\alpha$ administration; Treatment 6 - ewes in this group received no hormonal treatment.

Twenty-four hours after the last hormonal treatments three fertile Karakul rams with a good body condition score were introduced to the ewes in each experimental group (one ram per replicate of 10 ewes) for oestrous detection and mating. The oestrus was detected at 8-h intervals for five days and was recorded by observing the reaction of the females to the rams. This included restlessness, seeking out the ram, teasing the ram and standing immobile to be mounted (Gordon, 1997).

Data of lambing and the number of lambs born per ewe were recorded. Ewes lambing within a total observation period of 152 ± 7 days from exposure to rams were considered to have become pregnant due to the oestrus induced by the synchronization treatments (Sefidbakht *et al.*, 1978). Ewes that lambed after the observation period defined above were assumed to have become pregnant in the second or third oestrus following synchronization. The compactness of lambing, defined by total number of ewes lambed within a period of 15 days, was calculated for each treatment group. The percentage of ewes showing overt signs of

oestrus during a period of five days (from 6:00 to 18:00) for the 30 ewes in each treatment groups (oestrous response), the percentage of ewes that lambed to ewes mated at the induced oestrus (fertility rate), the percentage of lambs born to ewes lambing (fecundity), the percentage of lambs born to ewes mated at the induced oestrus (lambing rate) were recorded (Berhan & Van Arendonk, 2006), and the number of lambs born per ewes lambed (litter size) were used as measures of reproductive performance in the present study. Data were analyzed using a Chi-square test (SAS, 1996). Independent variables were treatment groups and the replicates. Due to the presence of unbalanced data, the effect of replicate was analysed using a General Linear Model. The effect of replicate was found to be non-significant for all analysed traits, and therefore data were pooled across replicates for the final analysis. The Duncan test was used to analyze the differences between means. The level of significance was set at $P < 0.05$ (Sokal & Rohlf, 1995).

Results

No ewe lost an intravaginal sponge or a CIDR during the treatment period. Two ewes (Treatments 1 and 6) died due to pregnancy toxaemia and data of these animals were excluded from statistical analyses. Data regarding oestrous response and ewes lambing are summarized in Table 1.

Table 1 Percentages of ewes in oestrus and number of lambs from first (induced) and later ovulations

Treatments	Oestrous response	No. of ewes lambing	
		First oestrus	Second and third oestrus
T1 (Prog. + eCG)	24 (80%) [d]	18 (62%) [b]	9 (31%) [b]
T2 (CIDR + eCG)	28 (93%) [c]	18 (60%) [b]	9 (30%) [b]
T3 (Sponge + eCG)	30 (100%) [c]	27 (90%) [c]	1 (3.3%) [a]
T4 (PGF + PGF))	11(37%) [b]	4 (13%) [a]	23 (76%) [c]
T5 (PGF + PGF + eCG)	9 (30%) [b]	4 (13%) [a]	23 (76%) [c]
T6 (Control)	6 (20%) [a]	5 (17%) [a]	22 (76%) [c]

[a, b, c, d] Means with different superscripts in the same column differ significantly ($P < 0.01$)

Table 2 Reproductive performance of Karakul ewes following oestrous synchronization using different hormonal treatments

Treatments: (n = 30)	Fertility rate (%)	Fecundity rate (%)	Litter size	Lambing rate (%)
T1 (Prog. + eCG)	75 [cd]	100 [b]	1.4 [b]	104.2 [d]
T2 (CIDR + eCG)	64 [c]	122 [c]	1.4 [b]	93 [cd]
T3 (Sponge + eCG)	90 [d]	133 [c]	1.4 [b]	126.6 [e]
T4 (PGF + PGF)	36 [a]	75 [a]	1.25 [a]	45 [a]
T5 (PGF + PGF + eCG)	44 [a]	75 [a]	1.5 [b]	66 [b]
T6 (Control)	83 [d]	100 [b]	1.0 [a]	83 [c]

[a, b, c, d] Means with different superscripts in the same column differ significantly ($P < 0.01$)

The highest number of ewes that lambed within the 152 ± 7 days to females treated per treatment group (30 ewes) was 27 (90%) for Treatment 3. The lowest number was four (13%) for Treatments 4 and 5. A significant difference ($P < 0.01$) was observed between treatments for number of ewes lambing. The

difference between treatments regarding the number of ewes lambing in the second and third oestrous periods was also significant ($P < 0.01$). The percentage of infertile (not lambing) ewes in this study ranged between 6.6 to 10% in all treatment groups.

A significant difference in multiple births was also observed between treatments ($P < 0.01$). The multiple birth percentages recorded in Treatments 1 to 6 were 22.2, 27.7, 41, 0, 25 and 0%, respectively. Overall, 27 (90%) of the ewes lambed. This effect in Treatment 3 was higher ($P < 0.01$) than in other treatment groups (Table 1). According to Table 2 the highest fecundity rate recorded was 133% in Treatment 3, while the lowest fecundity rate was recorded in Treatment 4 (75%).

There were significant differences ($P < 0.01$) in the fecundity rates between certain synchronization treatments. The highest fertility rate (90%) was recorded in Treatment 3 ($P < 0.001$), while the lowest (36% and 44%) was recorded in Treatments 4 and 5, respectively. The highest lambing rate was recorded in Treatment 3 (126.6%) and the lowest in Treatment 4 (45%). Regarding lambing rates, significant differences were recorded between the experimental groups ($P < 0.01$). The mean litter size ranged between 1 in Treatment 6 to 1.5 in Treatment 5.

Discussion

The results of the present study indicated that higher oestrous responses were induced when Karakul ewes were treated outside the breeding season with either MAP impregnated sponges (100%) or CIDRs + eCG (93%), compared to the other treatments. These results are comparable to the finding of Wheaton *et al.* (1993) and Zeleke *et al.* (2005). Greyling *et al*. (1994), using MAP plus 300 IU eCG outside the breeding season, reported a 100% oestrous response in Merino ewes. In contrast, Knight & Hall (1988) reported the oestrous response after CIDR removal to be significantly lower than following MAP sponge removal (87% *vs*. 94%). This was ascribed to a higher loss of CIDR's compared to the impregnated sponges (6.3% *vs*. 0.8%).

The high oestrous response (100%) within 24 h after MAP sponge withdrawal (T3) corresponded to a high percentage (90%) of ewes lambing compared to the other treatment groups. A compact rather than a protracted lambing season ensures that supplementary feeding can be more accurately timed in relation to the stage of pregnancy. This also facilitates the finishing of lambs in an appropriate time to be sold (Gordon, 1997).

The fertility rate in ewes treated with MAP sponges plus eCG in the present study was significantly higher than that of the other treatment groups. The present results were, however, different to those obtained by Tritschler *et al.* (1991) and Zeleke *et al*. (2005) who recorded lower fertility rates of 65% and 75%, respectively. However, differences in fertility rate between the present study and those of Tritschler *et al*. (1991) and Zeleke *et al*. (2005) could be ascribed to the differences in mating systems, breed, season, duration of treatment and overall managerial conditions. In the present study the lowest fertility rate was recorded in ewes treated with $PGF_2\alpha$ (with or without eCG). These findings are similar to those of previous reports published by Australian researchers who indicated the fertility rate would be depressed in ewes bred by artificial insemination (AI) following a $PGF_2\alpha$ induced oestrus (Lightfoot *et al.*, 1976; Fairnie *et al*., 1977). The fertility rate in Treatment 6 of the present study was 83% and not significantly different from that of the MAP sponges plus eCG group. This indicates that the hormonal treatment had no detrimental effect on ewe fertility.

The fecundity rate in Treatment 3 (133%) was significantly higher than in all other treatments. However, differences in fecundity rates between Treatments 1 and 6 were not significant. This was due to the death of the lambs born as triplets in Treatments 1 and 2 at the time of lambing. These results are in agreement with results of Mukasa *et al.* (1995), Zeleke *et al*. (2005) and Berhan & Van Arendonk (2006) in tropical sheep (100-150%), Dorper ewes (120.8%) and Horro ewes (116%), respectively. The highest (126.6%) and the lowest (45%) lambing rates in the present study were recorded in Treatments 3 and 4, respectively. In Ireland Crosby *et al*. (1991) evaluated the use of four intravaginal treatments fluorogestone acetate (FGA), MAP, progesterone and CIDR) combined with varying eCG dose levels in cyclic ewes and found that the lambing rate was significantly lower in the progesterone treated cyclic sheep than in those receiving FGA or MAP.

In the present study the mean litter size in Treatment 3 was 1.4, which is in agreement with the findings of Erasmus *et al*. (1994) and Zeleke *et al*. (2005). However, Ackermann (1993) and Schoeman *et al*.

(1995) reported a lower litter size (1.08) using a combination of MAP sponges and eCG for oestrous synchronisation in Dorper ewes. The differences in the litter size reported by research groups could be ascribed to breed differences. Those groups using eCG in the treatment had a higher litter size compared to those of groups that did not use eCG. From a production point of view it can be expected that MAP sponges with eCG used judiciously in Karakul sheep will increase twinning substantially without over-stimulation for undesirable triplets. As suggested by Nsoso & Madimabe (2003) the twinning rate should be enhanced further in this breed for two reasons. Firstly, to increase the number of lambs pelted and hence an increased farmers' income, and secondly, to reduce the number of ewes reared to prevent overgrazing and environmental degradation in the fragile ecosystem of central and southern Iran.

Conclusions

It is concluded that using a combination of MAP sponges plus 500 IU eCG for oestrous synchronisation in Karakul ewes outside the natural breeding season resulted in a higher oestrous response, fertility, fecundity and lambing rates, compared to the other treatments considered in this study. Furthermore, Karakul ewes receiving MAP sponges plus 500 IU eCG recorded a more compacted lambing period compared to the other treatment groups. The use of prostaglandin $F_2\alpha$ for oestrous synchronisation purposes in Karakul ewes outside the natural breeding season is not recommended, because of poor reproductive performance.

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