REPRODUCTIVE PERFORMANCE OF RAHMANI EWES IN BREEDING AND NON-BREEDING SEASONS ACCORDING TO DIFFERENT HORMONAL PROTOCOLS

Liza A. AbdEl-Rafaar; T. M. Ashmawy; A. E. AbdEl-Khalek

ABSTRACT

Thirty Rahmani ewes used to study the possibility of inducing estrous and ovulatory activities by hormonal treatments during the breeding season (September) or non-breeding season (May) for the purpose of improving fertility. Ewes were divided into three similar groups (10 heads/group) for each breeding season according to the type of hormonal treatments. Fresh diluted semen was used for AI, semen was deposited into the cervix. Results showed that estrus rate was higher (P<0.05) for T1 and T3 than T2, being the highest for T3 and in breeding than in non-breeding season. Estrus rate of treated ewes ranged from 60-100% in breeding season (September) and 40-90% in non-breeding season. Lambing rate was higher (P<0.05) for T3 and T1 than T2 in breeding and non-breeding season. Progesterone levels in all treatments in both seasons showed gradual increase in pregnant and non-pregnant animals from -2 to 3 days of sponge insertion to 7-12 days after sponge withdrawal, then showed additional increase in pregnant, while decreased less than 1 ng/ml in non-pregnants. The cost of one lamb production was the lowest for T3 comparing with T1 and T2, in breeding and non-breeding seasons. Attaining an adequate response in lambing rate and litter size of Rahmani ewes could be with the association of long P4 protocols (12 day) and 500 IU (in breeding season) or 700 IU (in non-breeding season) of hCG from the economic point.

INTRODUCTION

Reproductive seasonality is an adaptation mechanism developed in response to environmental changes and food availability across a given year. Estrus and ovulation synchronization in small ruminants can be controlled by different means, such as the administration of progesterone (P4) plus gonadotropins, such as equine chorionic gonadotropin (eCG), human chorionic gonadotropin (hCG) and pregnant mare serum gonadotropins (PMSG) to counteract reproduction seasonality (Contreras-Villarreal et al., 2016), using either artificial insemination (AI) or natural mating (Martinez-Ros et al., 2019a). In temperate regions of the world from regions 25° N, to the higher latitudes >40° N and S, reproductive seasonality occurs and negatively affects products for marketing of sheep and goats (Gonzalez-Bulnes et al., 2020). The majority of ewe breeds differ in reproductive behavior depending on season changes, latitude/longitude, the length of the photoperiod and other factors (Silva et al., 2020).

Synchronization or induction of estrus in ewes is an interesting tool for increasing the pregnancy rate. Modern husbandry of ewes has improved the efficiency of extensive production and controlled the reproductive process for intensive production. Basically, the synchronization of estrus in ewes focuses on the manipulation of the estrous cycle (Zonturlu et al., 2011), either at the luteal or the follicular phase. The success of reproductive technologies is largely dependent on the interaction between the ovarian status and the hormonal treatments needed for allowing their application; progesterone for inducing and synchronizing estrus occurrence and gonadotrophins for inducing follicular growth and ovulation (Daly et al. 2020). Intravaginal progestagen sponge, followed by PMSG injection was carried out to synchronize estrus during the breeding season (Menegatos et al., 1995), or to induce oestrus out of season (Zarkawi et al., 1999). Thus, the objective of this study was to evaluate the impact of three different protocols for estrus synchronization during breeding and induction of estrus in non-breeding seasons on reproductive performance of Rahmani ewes.

MATERIALS AND METHODS

Thirty Rahmani ewes of the flock at Mehalet Mousa Experimental Station (2-7 years
old and 50-55 kg body weight) were used to study the possibility of inducing estrous and ovulatory activities by hormonal treatments during anoestrus (May breeding season) and synchronization of estrus and ovulation during the breeding season (September breeding season) for the purpose of improving fertility.

Animals were housed in semi-open sheds and fed concentrate feed mixture and roughages all the year-round plus 5 kg Egyptian clover during winter feeding or 1.5 kg clover hay during summer feeding (according to NRC (2007) requirements) with free access to trace mineralized salt lick blocks and drinking water all time.

Ewes were divided into three similar treatment groups according to age, body weight and physiological condition (10 heads/group) as follows:

First group (T1): ewes treated with 45 mg Cronolone vaginal impregnated sponges (Flugestone acetate, FGA; Intervet International B.V. Boxmeer-Holland). The sponge inserted and remained intravaginal for 12 days. Each ewe intramuscularly injected with 500 IU PMSG (FOLLIGON, Intervet International B.V. Boxmeer-Holland) and 0.7 mL PGF$_2$α (Estrumate, Coopers Animal Health LTD, Berkhamsted-England) on the day of sponge withdrawal (Day 12) during the breeding season or 700 IU hCG 48 h before sponge withdrawal (Day 10) and 0.7 mL PGF$_2$α on the day of sponge withdrawal (Day 12) during the non-breeding season.

Second group (T2): ewes treated with 45 mg Cronolone vaginal impregnated sponges. The sponge inserted and remained intravaginal for 12 days. Each ewe intramuscularly injected with 1 mL GnRH analogue (Receptal, Intervet International B.V. Boxmeer-Holland) and 0.7 mL PGF$_2$α on the day of sponge withdrawal (Day 12) during the breeding season or 1 mL GnRH analogue 48 h before sponge withdrawal (Day 10) and 0.7 mL PGF$_2$α on the day of sponge withdrawal (Day 12) during the non-breeding season.

Third group (T3): ewes treated with 45 mg Cronolone vaginal impregnated sponges. The sponge inserted and remained intravaginal for 12 days. Each ewe was intramuscularly injected with 500 IU Chorionic gonadotrophin (Human Chorionic gonadotrophin, hCG 5000 IU, Eipico, El-Nile Company, Egypt) and 0.7 mL PGF$_2$α on the day of sponge withdrawal (Day 12) during the breeding season or 700 IU hCG 48 h before sponge withdrawal (Day 10) and 0.7 mL PGF$_2$α on the day of sponge withdrawal (Day 12) during the non-breeding season.

The experimental design of different hormonal protocols in breeding and non-breeding seasons are illustrated in Fig. 1.

Semen processing:

Fresh diluted semen was used for AI. Semen had been collected and diluted (1 semen: 4 extender) just before insemination. Collection of semen carried out by the use of artificial vagina. The Tris-yolk extender used for the extension of fresh semen. The extender was prepared and kept at 5°C for 24 h before semen dilution. Each 100 mL of Tris-yolk extender consisted of 3.028 g Tris, 1.675 g citric acid, 1.250 g glucose, 5 mL egg yolk, 1 mL antibiotics including 100.000 IU penicillin and 100.000 IU streptomycin, then distilled water was added up to 100 mL. All chemicals used for preparation of extender purchased from Sigma chemical company, P.O. Box 14508, ST. Louis, MO 63178 USA.

The extender gently shacked and warmed up to 37°C using a water bath before semen dilution. Immediately after semen collection the volume was measured and liquors of raw semen were taken for determination of sperm motility according to the method described by Bane (1952). Only ejaculates of ≥70% initial motility were diluted (1 part semen: 4 parts extender) at 37°C. Sperm concentration was estimated as 300 x 10$^6$ sperm/ml diluted semen and sperm motility remained over 70% before use. Insemination carried out using a simple inseminating pipette with fine blunt bent end and a vaginal speculum. Semen deposited into the cervix as far as possible (about 1 cm).
Day 0 | Day 10 | Day 12
---|---|---
**All treatments (T1, T2, and T3)**
Sponge insursion➔ Sponge withdrawal
**Breeding season**
T1
Non-breeding season
T2
Non-breeding season
T3
Non-breeding season

**Day 0**

**Breeding season**
500 IU PMSG + 0.7 mL PGF2α

**Non-breeding season**
700 IU PMSG➔ 0.7 mL PGF2α
1 mL GnRH➔ 0.7 mL PGF2α
500 IU hCG➔ 0.7 mL PGF2α

**Blood sampling:**
Blood samples taken via the jugular vein from all ewes in each of experimental group at 8 am into evacuated heparinized tubes (10 mL). Samples of each treatment group were taken on days -2 (pre-treatment), 0 (sponge inserted), 3, 7, 10, 11, 12, 32, 33 and 34 of sponge insertion. Just after sampling, the blood samples separated to obtain plasma by centrifugation of blood at 2500 rpm for 15 min. Plasma was packed in labeled plastic tubes and stored at -20°C until assayed later for progesterone (P4) concentration. Concentration of P4 was determined based on competition reaction (Bojanic et al., 1991) on samples of five selected ewes (3 ewes respond to lambing and one or two non-responded ewes) of each treatment group.

**Statistical analysis:**
Data were analyzed using (SAS. 2007), GLM analysis of variance, for study the effect of treatment (T1, T2 and T3) within each season or the differences between both seasons (overall mean). The statistical model $Y_{ij} = \mu + A_i + B_j + e_{ij}$ was used, where, $Y_{ij}$ : the vector of observation, $\mu$: overall means, $A_i$: the effect of $i^{th}$ season ($i = (1)$ breeding season and $(2)$ non-breeding season, $B_j$: effect of $j^{th}$ treatment ($j = 1, 2$ and $3$), and $e_{ij}$: random error associated. Duncan Multiple Range test (Duncan, 1955) was used to get the mean separations among treatments.

**RESULTS AND DISCUSSION**
Effect of hormonal treatments (T1, T2 and T3) within each season and effect of season on rate, onset, and duration of estrus are presented in Table 1. In each season, estrus rate was higher (P<0.05) for T1 and T3 than T2, being the highest for T3 and in breeding than in non-breeding season. Estrus rate of treated ewes ranged from 60-100% in breeding season (September) and 40-90% in non-breeding season. Although the estrus rate was lower in T2 than in T1 and T3 in both breeding seasons, onset of estrus was the earliest (P<0.05) and estrous duration was the shortest in T2 but did not differ.
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significantly from T1 at breeding season. As affected by season, onset of estrus was earlier (30.6 hr) \((P<0.05)\) in breeding than non-breeding season (41.8 hr), but estrous duration was not affected by season.

The most used hormonal treatments in estrous synchronizing protocols for sheep are those based on P4 or its analogues (Abecia et al. 2012). Controlled internal drug release (CIDR) is an intravaginal device impregnated with 0.3 g of natural progesterone (Wheaton et al. 1993) designed for use between 12 and 14 days in sheep (Viñoles et al. 2001). The device inhibits GnRH secretion and consequently prevents the release of gonadotropins, especially luteinizing hormone (Rubianes et al. 2003).

Table 1. Estrus rate, onset, and duration in response to hormone treatment in ewes of treatment groups during the breeding and non-breeding season.

<table>
<thead>
<tr>
<th>Season</th>
<th>Treatment</th>
<th>Estrus Rate (%)</th>
<th>Onset (h)</th>
<th>Duration (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding (September)</td>
<td>T1 (PMSG)</td>
<td>(9/10) 90(^a)</td>
<td>30.3±0.70(^b)</td>
<td>30.8±0.88(^b)</td>
</tr>
<tr>
<td></td>
<td>T2 (GnRH)</td>
<td>(6/10) 60(^b)</td>
<td>28.7±1.22(^b)</td>
<td>27.7±4.99(^b)</td>
</tr>
<tr>
<td></td>
<td>T3 (hCG)</td>
<td>(10/10) 100(^a)</td>
<td>32.7±0.41(^a)</td>
<td>32.5±1.81(^a)</td>
</tr>
<tr>
<td></td>
<td>Overall mean</td>
<td>(25/30) 83.3(^A)</td>
<td>30.6±0.77(^B)</td>
<td>30.3±2.56</td>
</tr>
<tr>
<td>Non-breeding (May)</td>
<td>T1 (PMSG)</td>
<td>(8/10) 80(^a)</td>
<td>40.4±1.04</td>
<td>31.4±0.57</td>
</tr>
<tr>
<td></td>
<td>T2 (GnRH)</td>
<td>(4/10) 40(^b)</td>
<td>43.5±2.13</td>
<td>30.3±1.52</td>
</tr>
<tr>
<td></td>
<td>T3 (hCG)</td>
<td>(9/10) 90(^a)</td>
<td>41.6±1.04</td>
<td>31.8±0.57</td>
</tr>
<tr>
<td></td>
<td>Overall mean</td>
<td>(21/30) 70.0(^B)</td>
<td>41.8±1.40(^A)</td>
<td>31.1±0.88</td>
</tr>
</tbody>
</table>

\(^a\) and \(^b\): Means of treatments bearing different small letters within each season differ significantly \((P<0.05)\).

\(^A\) and \(^B\): Overall means for each season bearing different capital letters differ significantly \((P<0.05)\).

Once the device is removed, an injection of equine chorionic gonadotropin (eCG) is applied (Abecia et al. 2011), which has an effect of follicle-stimulating hormone (FSH) and LH to enhance ovulation (Martinez-Ros et al. 2019b). The present results indicated a superior estrus response obtained in association with PMSG given 2 days in advance of FGA-sponge removal as early reported by East and Rowe (1989), who used an intravaginal sponge containing 30 mg FGA for 16 days plus an injection of 250 IU PMSG two days before sponge removal. They obtained higher estrus rate, being 95% during the transition from non-estrus to breeding season in Toggenburg, Alpine, Saanen and Anglo-Nubian goats. Stimulation of follicular growth in the ovary by exogenous PMSG led to higher estrus response by anestrus goats only in the intravaginal sponge treatment (Greyling and Van Niekerk, 1991). The present results indicate that this was likely to happen in response to FGA-sponge treatment. Meanwhile, results of GnRH given (T2) at may indicate that GnRH as an estrous synchronizing agent is only effective during breeding season. It postulated that this GnRH might cause follicular growth only in active ovaries. In consistent with our results, Martinez-Ros et al. (2019a) obtained estrus presentation at 33.8 h with an interval of 24-40 h by using seven-day protocols with new CIDR associated with 5 mg of prostaglandin and 400 IU of eCG. Similar results were obtained by Biehl et al. (2019) using 300 IU of eCG. They found that mean of estrus occurrence was 34.9 h, with the highest concentration of presence between 36 and 41.9 h. In the present study, the use of eCG reduces the interval to ovulation by enhancing the onset of estrus (Cox et al., 2012) by stimulating the recruitment and maturation of follicles and oocytes (Manes and Ungerfeld, 2015). With lower eCG doses, gonadotropin stimulation is reduced. This led Cox et al. (2012) to notice the beginning of estrus at 32.8 h when using 350 IU of eCG, whereas in sheep with no doses of eCG, they had a wider interval (45.3). Bazzan et al. (2013) observed onset of estrus between 24 and 72 h using 200 IU of eCG with an average of 48 h.
In our study, there is a successful rate of estrus in the non-breeding season, but this result was higher with late incidence and longer duration in the non-breeding season in comparison with the breeding season. In this respect, Pierson et al. (2001) synchronized estrus in Dwerf goats using MAP-sponges + eCG + PG during different times of the year. They found different intervals from sponge removal to onset of estrus, being 25.0, 28.9 and 40.9 h during November, July and March, respectively.

According to the present results, the use of P4 + gonadotropin (PMSG or hCG) is useful for increasing estrus response of synchronized ewes in breeding season or estrus induction in anestrous in non-breeding season, which is useful especially when timed insemination protocols are implicated.

### Fertility and lambing rate:
Lambing rate and litter size of ewes in response to different hormonal treatment in breeding and non-breeding seasons are presented in Table 2 which indicate that lambing rate (based on total number of ewes) was higher (P<0.05) for T3 and T1 than T2 in breeding and non breeding season, while overall mean was non significantly higher in breeding than in non breeding season, based on estrus, lambing rate was not affected by treatment in breeding season being the highest for T3, but was higher (P<0.05) for T1 and T3 than T2 in non breeding season, with non significant differences between both season. It is of interest to note that all ewes responded to estrus with T3 in non-breeding season were lambed. Litter size of ewes was not affected significantly by treatment or season, but it was the highest for T3 in breeding season and with T1 in non-breeding season, and also in breeding than in non-breeding season.

<table>
<thead>
<tr>
<th>Table 2. Fertility (%) in response to hormone treatment in ewes of different seasons.</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Season</strong></td>
<td><strong>Treatment</strong></td>
<td><strong>Fertility (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total ewes</td>
<td>Ewes in estrus</td>
<td>Total number of lambs born</td>
</tr>
<tr>
<td>Breeding (September)</td>
<td>T1 (PMSG)</td>
<td>(8/10) 80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(8/9) 88.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>T2 (GnRH)</td>
<td>(5/10) 50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>(5/6) 83.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>T3 (hCG)</td>
<td>(9/10) 90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(9/10) 90.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Overall mean</td>
<td>(22/30) 73.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(22/25) 88.0</td>
<td>28</td>
</tr>
<tr>
<td>Non-breeding (May)</td>
<td>T1 (PMSG)</td>
<td>(7/10) 70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(7/8) 87.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>T2 (GnRH)</td>
<td>(3/10) 30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>(3/4) 75.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>T3 (hCG)</td>
<td>(9/10) 90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(9/9) 100&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Overall mean</td>
<td>(19/30) 63.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>(19/21) 90.4</td>
<td>21</td>
</tr>
</tbody>
</table>

<sup>a</sup> and <sup>b</sup>: Means of treatments bearing different small letters within each season differ significantly (P<0.05).

<sup>A</sup> and <sup>B</sup>: Overall means for each season bearing different capital letters differ significantly (P<0.05).

In the breeding season of the ewe, GnRH (Buserlin) induced LH surge causing ovulation or luteinization of the ovarian follicles (Beck et al., 1996). During seasonal anoestrus, the occurrence of LH rise, and hence ovulation, appeared to be prevented by a heightened response to estradiol negative feedback (Goodman et al., 1981). Alternatively, the absence of response to GnRH treatment out of the breeding season may be related to the absence of progesterone priming effect during the transition period, immediately before the breeding season (Legan et al., 1985). It shown that sufficient priming of progesterone is
necessary for sensitization of the ovary to LH discharges after inactivity. It is possible that progesterone priming may exert its beneficial effect on subsequent luteal function, indirectly through the hypothalamic-pituitary axis, by suppressing pulsatile LH secretion. This might arrest follicle development to an extent that all potential ovulatory follicles are effectively at an appropriate stage of development to be able to fully respond to the GnRH-induced follicular phase and develop into normal CLs after ovulation. The effect of progesterone may also be exerted directly at the level of the follicle to alter its ability to respond to gonadotrophin stimulation (e.g., through intra-ovarian growth factors), thereby ensuring normal luteal development after ovulation (Haresign et al., 1996).

The exogenous progesterone used to imitate the role of the corpus luteum for the control of the estrous cycle, avoiding the occurrence of ovulations during progesterone supplementation and allowing them at progesterone removal. However, such protocols neglected to take into account the follicle-destined to release an oocyte able to result in a pregnancy and to develop a corpus luteum supporting such pregnancy. In fact, 12 to 14 days of treatment may affect the quality of preovulatory follicles (Viñoles et al., 1999) and, therefore, the fertility of oocytes and the function of corpora lutea (Berlinguer et al., 2007). The basis for the administration of progesterone is the decrease in secretion of luteinizing hormone (LH) that prevents the occurrence of estrus, the preovulatory LH surge, and ovulation until the progestative treatment is withdrawn (Goodman and Karsch, 1980). The decrease in LH secretion induced by exogenous progesterone causes large follicles (gonadotrophin-dependent follicles), 4 mm in size in the case of sheep (González-Bulnes et al., 2004) present in the ovaries to become atretic, allowing follicular turnover and the emergence of a new follicular wave (Leyva et al., 1998). However, sometimes, progesterone release after 12–14 days of treatment is too low to adequately suppress LH. The failure in suppressing LH secretion causes abnormal follicular development with large, persistent follicles (Viñoles et al., 1999). Afterward, the ovulation of these aged follicles affects fertility (Ungerfeld and Rubianes, 2002).

**Progesterone concentration (ng/ml):**

Table (3) shows progesterone levels before and during treatment (FGA-sponge) in breeding and non-breeding season. Progesterone levels in all treatments in both seasons showed gradual increase in pregnant and non-pregnant animals from -2 to 3 days of sponge insertion to 7-12 days after sponge withdrawal, then showed additional increase in pregnant, while decreased less than 1 ng/ml in non-pregnant. These results indicate positive impact of all treatments on increasing P4 level of ewes during non-breeding season. In Rahmani ewes of the same flock, plasma progesterone levels during anestrus were <0.5 ng/ml in May and <0.1 ng/ml in March/April to late June and fluctuated around 0.45 (0.02-0.71 ng/ml) up to the onset of the breeding season (Gabr, 1986).

Progesterone concentrations increased to >0.80 ng/ml after insert sponge (day -2 to 3), while on days 7-12, subluteal concentrations >2 ng/ml were obtained from sampled ewes; this agrees with Wheaton et al. (1993), who stated that P4 concentration increase dramatically after CIDR inserted. This increase in P4 is required to disinhibit GnRH secretion and trigger the release of gonadotropin, inducing the onset of estrus and ovulation (Amiridis and Cseh, 2012). This indicates the positive relationship between progesterone level during treatment and the resultant fertility, which is going in line with the hypothesis that an inadequate progestagen level on the day of sponge removal may be responsible of the variability in the occurrence of estrus after hormonal treatment of anestrous dairy goats (Gordon, 1996). The variability between animals in timing of estrus after administration of a synchronization treatment seems to explain the low rate of fertility in goats inseminated at a predetermined time after sponge removal (Freitas et al. 1997). Nevertheless, Freitas et al. (1994) tested such hypothesis and found that a higher level of progesterone at the end of treatment led to some loss of fertility.
Table (3): The mean of progesterone concentration (ng/ml) in some stages for ewes under different hormonal treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pregnancy status</th>
<th>Day -2 to Day 3</th>
<th>Day 7 to Day 12 (sponge)</th>
<th>Day 32 to 34 after sponge withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breeding season (September)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>(PMSG) + (3)</td>
<td>1.86±0.01</td>
<td>2.60±0.22</td>
<td>4.87±0.19</td>
</tr>
<tr>
<td></td>
<td>- (2)</td>
<td>1.08±0.01</td>
<td>3.25±0.32</td>
<td>0.59±0.90</td>
</tr>
<tr>
<td>T2</td>
<td>(GnRH) + (3)</td>
<td>1.17±0.02</td>
<td>2.62±0.05</td>
<td>0.77±0.05</td>
</tr>
<tr>
<td>T3</td>
<td>(hCG) + (1)</td>
<td>0.99±0.00</td>
<td>3.15±0.00</td>
<td>4.36±0.00</td>
</tr>
<tr>
<td>Non-breeding season (May)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>(PMSG) + (3)</td>
<td>0.83±0.01</td>
<td>2.49±0.33</td>
<td>4.89±0.03</td>
</tr>
<tr>
<td></td>
<td>(GnRH) - (3)</td>
<td>0.90±0.05</td>
<td>3.67±0.30</td>
<td>0.87±0.03</td>
</tr>
<tr>
<td>T2</td>
<td>(hCG) + (3)</td>
<td>0.95±0.01</td>
<td>2.28±0.21</td>
<td>3.89±0.03</td>
</tr>
<tr>
<td>T3</td>
<td>(hCG) - (1)</td>
<td>0.85±0.00</td>
<td>3.39±0.00</td>
<td>0.44±0.00</td>
</tr>
</tbody>
</table>

(+) pregnant, (-) not pregnant

With respect to GnRH-treatment, where the response occurred, there was wide difference in progesterone level during treatment between does conceived and those failed to conceive in both seasons in favor of pregnancy. This may referred to the smaller sizes of the ovulated or luteinized ovarian follicles followed GnRH treatment during seasonal anoestrus than during the breeding season. Follicular sizes in the ewe were smaller in the anoestrous than in the breeding season (Mallampati et al., 1971) and their development is inhibited out of season (Wood and Foster, 1992). This may be explained as a result of possible higher luteal activity caused by higher pituitary LH output as the animal approaches and goes into the breeding season.

From artificial insemination time to the attainment of progesterone plateau (sustainable high levels) in pregnant ewes, the average progesterone level ranged from 3.74 to 4.87 ng/ml on the breeding season and 3.89 to 4.89 ng/ml on the non-breeding season. This study was designed to test the efficiency of a recently developed method for synchronization of ovulation using a protocol of combined treatment with FGA-sponge, PGF2α and PMSG, GnRH or hCG. In both treatments, the predetermined time based artificial insemination has proven as practical and less costing, since ovulation in response to treatment.

In the breeding season, high fertility rates have been resulted due to both treatments with CIDR or FGA-sponge + PMSG and CIDR or FGA-sponge + hCG resulted in higher fertility and high synchronization. So, it recommended in the breeding season to use the present protocol for synchronization of ovulation and, subsequently, lambing with insemination to be based on pre-determined time.

On experimental days 7 and 12, there was an increase in the concentration of P4 (>1 ng/mL) in all ewes, showing that ovulation was induced in the three treatments, although P4 concentrations were higher in 10 d CIDR treatment. The highest P4 concentration was observed at day 7 with the 10 d CIDR 300 IU eCG (P<0.05) ewes and then reached a plateau on days 11, 13, and 15 with no difference among groups (P>0.05). At day 17, an evident reduction...
REPRODUCTIVE PERFORMANCE OF RAHMANI EWES IN BREEDING AND NON-BREEDING SEASONS ACCORDING TO DIFFERENT HORMONAL PROTOCOLS

in the mean concentration of P4 was observed in ewes from both 12 d CIDR treatments and 10 d CIDR-400 IU eCG treatment (Arosh et al., 2004). Bazer (2013) stated that 12 to 13 days after mating is a critical period in sheep gestation due to the beginning of corpus luteum regression.

Concerning the lower response to FGA-sponge + GnRH out of the breeding season, it may be a matter of dominance of the estradiol negative feedback, absence of progesterone priming effect or both. The question emerging here is what would be the response if the dose of GnRH is increased, and/or if progesterone is used for its priming effect? More studies needed to elucidate these issues.

Economic efficiency:
The economic efficiency of the experiment (Table 4) was calculated according to the lamb production, the cost of one lamb

Table (4): Effectiveness of pre-determined time based insemination in treated ewes under different hormonal treatments.

<table>
<thead>
<tr>
<th>Treat.</th>
<th>N</th>
<th>Ewes showed estrus</th>
<th>Economic efficiency (EP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ewes lambed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>September (Breeding season)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>10</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>T2</td>
<td>10</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>T3</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Overall</td>
<td>30</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>May (non-breeding season)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>T2</td>
<td>10</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>T3</td>
<td>10</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Overall</td>
<td>30</td>
<td>21</td>
<td>18</td>
</tr>
</tbody>
</table>

a and b: Means of treatments bearing different small letters within each season differ significantly (P<0.05).
A and B: Overall means for each season bearing different capital letters differ significantly (P<0.05).
(1) Lambed ewes /total ewes (2) Lambed ewes/ewes showed estrus
Price of hormone treatments: One Sponge = 110 Egyptian Pound (EP), 10 ml Estrumate = 100 EP, 1000 IU PMSG = 200 EP, 10 ml GnRH = 150 EP and 5000 hCG = 90 EP.

production was the lowest for T3 comparing with T1 and T2, in breeding and non-breeding seasons, and as overall mean during the breeding season as compared to non-breeding season. These results mean that the conceivable ewes due to FGA-sponge treatment out of the breeding season are confined to those showing estrous behaviour. With time advance, the conceivable is being associated with both ewes in estrus or in anestrus, partly during the transition period and fully in the breeding season. It is interesting to note that GnRH-treatment (T2) had small effect on the treated ewes at breeding and non-breeding season since
it is clear that, T3 (hCG) had the highest fertility and lowest cost to produce one lamb.

It is important to note that, in almost all studies, hormonal methods are evaluated on: (1) their efficiency to synchronize estrus and ovulation. (2) fertility (3) economic efficiency. The ultimate aim of any estrous synchronization method is to allow artificial insemination at a predetermined time after the end of treatment. When fertility is low, interpretation will be that AI has been performed too early, with oocyte arriving in the oviduct after the death of spermatozoa, or too late so that the quality of oocyte depressed.

**Conclusion:**

In the present study, we obtained an adequate response of lambing rate and litter size for Rahmani ewes with the association of long P4 protocols (12 day) and 500 IU (in breeding season) or 700 IU (in non-breeding season) of hCG considering the economic point.

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الدالة الانتاجية للنعاج الرحماني داخل وخارج موسم التناسل باستخدام طرق مختلفة من المعاملات الهرمونية

ليزا احمد عبد الرافع1، طارق عشماوى محمود1، عبد الخالق السيد عبد الخالق2

1 معهد بحوث الانتاج الحيواني 2 كلية الزراعة، جامعة المنصورة

تم استخدام 60 نعجة رحماني حيث تم استحداث وتظليم الشيف والتبويض باستخدام المعاملات الهرمونية داخل وخارج موسم التناسل لتحسين نسبة الخصوبة. قسمت النعاج إلى 3 مجموعات متساوية (10 نعاج/معالمة) لكل موسم تناسل حسب المعالمة الهرمونية. وتم التقييم احصائياً بسائل منوى مخفف طازج في عمق الرحم. النتائج المتحصل عليها داخل موسم التناسل اوضحت ان معدل الشيف كان أعلى في المعالمة T2 عن T1، T3 وكانت أعلاه T3 سواء داخل أو خارج موسم التناسل. معدل الشياع T3 تراوح بين 60-100% داخل موسم التناسل و40-90% خارج موسم التناسل. معدل الولادة كان أعلى معنواً في المعالمة T2 عن T1 في داخل أو خارج موسم التناسل. مستوي هرمون البروجسترون في كل المعالمات في كلا من مواسم التناسل T1 كان أعلى في النعاج العشار عن تلك الغير عشار بداية من اليوم 2 إلى 3 من تركيب الاستئصالات المهبلية و7-12 يوم بعد نزع الاستئصالات كما كان هناك ارتفاع في النعاج العشار بينما تناقص إلى 1 ناجر/جمل في النعاج العشار. التكلفة لانتاج مولود كانت أقل في T3 مقارنة بالمجموعتين T1، T2 سواء داخل أو خارج موسم التناسل. يستنتج من البحث أنه للحصول على استجابة عالية في معدلات الولادة و معدل التناسل للنعاج الرحماني يمكن استخدام الاستئصالات المهبلية لمدة 12 يوم مع حقن 500 وحدة دولية hCG خلال موسم التناسل أو 700 وحدة دولية hCG خارج موسم التناسل. وذلك هو الأفضل من الناحية الاقتصادية.