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Effects of Breed and Prostaglandin Administration on Reproductive Performance and Profitability of Egyptian Ewes

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Abstract

The object of this study was to investigate the influence of breeds, equine chorionic gonadotropin (eCG) and prostaglandin F2alpha ($PGF_{2\alpha}$) administration on reproductive performance in Egyptian ewes in relation to the economic efficiency of these hormonal treatments. For the estrus cycle control, the ewes received on Day 0 an intravaginal implant with 40 mg of Flugestone acetate. On 12th day the intravaginal implants were removed and animals were divided into other two groups: Group 1) 36 ewes received only 400 IU eCG at the time of removal of the sponges (Ossami, n = 15; Rahmani, n= 12; Crossbred, n = 9). Group 2) 32 ewes received 400 IU eCG plus 0.5 ml PGF2á at the time of removal of the sponges (Ossami, n = 10; Rahmani, n= 12; Crossbred, n = 10). Estrus response, onset of estrus, pregnancy rate, lambing rate, litter size and multiple births were recorded. The results revealed that, overall estrus response was slightly higher in ewes that treated with eCG+$PGF_2\alpha$ than those received eCG only. Administration of eCG plus $PGF_2\alpha$ had better effect on onset of estrus at first 32 h than groups treated with eCG only. Litter size within breeds was significantly higher in crossbred ewes treated with $PGF_2\alpha$ in comparison with local breeds. Rahmani ewes treated with eCG had greater percentage of multiple births than Ossemi and crossbred ewes. Administration of eCG plus $PGF_2\alpha$ increased multiple births in crossbred ewes in comparison with local breeds. It was concluded that crossbred ewes had a better reproductive response to prostaglandin administration than local breed ewes. Injection of eCG was more profitable than eCG plus $PGF_2\alpha$ administration through increasing mean litter size and multiple births.

Keywords: Ewe, Prostaglandin, Reproductive performance, Profitability

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Introduction

Cyclic variation in natural resources, such as temperature and food availability, leaded to the development of seasonal reproduction of animal species, in order to give birth at the optimal time of year. Therefore, favourable temperature and food availability conditions will permit the neonates to grow well (Thiéry *et al.*, 2002). Sheep are seasonally polyestric breeds. The estrus season is connected with the shortening of the day, i.e. a reduction in the light intensity (Strmsnik *et al.,* 2002).

Estrus synchronization allows for parturition at suitable times to take advantage of niche markets, feed supplies, labor, and rising price trends. Successful control of estrus and ovulation in sheep would provide a number of practical and economic advantages, allowing also the exploitation of genetically superior sires. Estrus synchronization is a valuable management tool that has been successfully employed to enhance reproductive efficiency particularly in ruminants. In small ruminants, estrus synchronization is achieved either by reducing the length of the luteal phase of the estrus cycle with prostaglandin F2alpha ($PGF_2\alpha$) or by the extending the cycle artificially with exogenous progesterone (Jainudeen *et al.,* 2000; Kusina *et al.,* 2000).

Different protocols of estrus synchronization using progestins have been recorded (Simonetti *et al.,* 2000; Naqvi *et al.*, 2001; Boscos *et al.,* 2002; Timurkan and Yildiz, 2005; Ataman and Akoz, 2006; Moeini *et al.,* 2007; Duygu and Karaca, 2009; Koyuncu and Ozis, 2010; Duygu and Koker, 2011; Nasroallah *et al.,* 2012). This study was carried out to investigate the influence of breeds and equine chorionic gonadotropin (eCG) and prostaglandin F2alpha ($PGF_{2\alpha}$) administration on reproductive performance in Egyptian ewes in relation to the economic efficiency of these hormonal treatments.

Material and methods

This study was carried out from June 15, 2011 till January 15, 2012 at Sakha Animal Production Research Station (31°06’36"N latitude and 30°55’48"E longitude), in Kafr El-Sheikh Governorate.

Animals: A total of 68 non-lactating ewes, aging 24-40 months, and 6 healthy rams, aging 2-3 years (4 local and 2 cross breeds) were used in the experiment. All animals had a body score from 3.5 to 4.5 in 0 to 5 scales (Santucci and Maestrini, 1985). The ewes were separated from the males two months before the beginning of the experiment.

Animal housing and feeding

The animals were housed indoors with free access to outside yards. The ewes were given green fodder (*Trifolium Alexandrium*) during the green season, hay in the dry one. Concentrate mixture was included corn grains 45.3 %, decorticated cotton seed 11%, soya

bean meal 12%, wheat bran 29%, limestone 1.8%, 0.22% sod. bicarbonate, 0.4 common salt, and 0.28% mineral mixture. This basal diet contained 15.5% crude protein and 65 % TDN and was fed to all groups. Water and mineral licks were available *ad libitum.*

Treatment

Two local (Rahmani and Ossami) and one cross (with exotic Finnish Landrace) breeds were randomly assigned in a 3 x 2 factorial design. Based on body weight and age, each breed was grouped into two treatments with or without prostaglandin $F_2\alpha$ ($PGF_2\alpha$) injection. For the estrus cycle control, the ewes received on Day 0 (day of the beginning of the treatment) an intravaginal implant with 40 mg of Flugestone acetate (FGA, Chronogest® CR; Intervet, Netherlands). After 12 days, the intravaginal implants were removed and 36 ewes received 400 IU eCG (Folligon™, Intervet, Netherlands) by intramuscular injection (Ossami, n = 15; Rahmani, n= 12; and Cross, n = 9) and 32 ewes received intramuscularly 400 IU eCG plus 0.5 ml $PGF_2\alpha$ (each ml contains 263 mg Cloprostenol sodium, equivalent to 250µg Cloprostenol; Estrumate, Schering-Plough, Germany) at the time of removal of the sponges (Ossami, n = 10; Rahmani, n= 12; cross, n = 10) (Table 1).

From day 13 to day 15 the ewes were kept with the teaser rams with marker, aiming the identification of the bred ewes. The ewes were visibly on heat were artificially inseminated using fresh semen which was collected from the ram of each breed. Teasers were turned in with the ewes 10 days after AI and return ewes were recorded. Ewes were examined for pregnancy 35-40 days after artificial insemination by real time ultrasonography (US 1700, NOVEKO, Canada; 5MHZ) and recorded.

Ewes were housed in a semi-covered large pen (6m×20 m). These ewes were given free access to green fodder

Table 1: Experimental design

Breed	Subgroup	N	Treatment	
			eCG	$PGF_2\alpha$
Ossemi (O)	O1	10	400 IU	0.5 ml
	O2	15	400 IU	—
Rahmani (R)	R1	12	400 IU	0.5 ml
	R2	12	400 IU	—
Crossbred (C)	C1	10	400 IU	0.5 ml
	C2	9	400 IU	—

(*Trifolium Alexandrium*) during the green season, hay in the dry one and fresh drinking water. Concentrate mixture (cotton seed cake, soya bean meal, yellow corn, limestone and mineral mixture) containing 16.6% crude protein, 12.7 % crude fiber and 73.4 % TDN was provided before breeding at a rate of 1250 gm daily / ewe.This amount was decreased till reach 400 gm / head during pregnancy and increased gradually again at the late stage of pregnancy (1000 gm/head, last 4-6 weeks). Ewes were drenched with an anthelmintic drug (Hapadex, 20 ml / 50 kg of body weight, Schering-Plough Company) at the start of experiment and at one month after birth. At week 17th of pregnancy, ewes were subcutaneously vaccinated with 2 ml of Clostridia vaccine (Co-vaccine, Schering-Plough Company).

Data recording: The following reproductive parameters were evaluated in each group: estrus response (number of ewes showing estrus/total ewes treated in each group x 100), the onset of estrus (the time from removal of the sponges to the onset of heat in each ewe), pregnancy rate (number of ewes pregnant/number of ewes showing estrus and mated in each group x 100), lambing rate (number of ewes lambing/ number of pregnant ewes in each group x 100), litter size (number of total lambs/number of lambing ewes in each group) and multiple births (number of ewes lambed twins or triplets/ number of lambing ewes in each group). Economic parameters including hormonal treatment cost, labor and returns from newly born at weaning were calculated.

Statistical analysis

Data were analyzed with ANOVA-test to compare litter size among groups and expressed as the Means ± S.E. *Chi-square* test to compare estrus response, onset of estrus, pregnancy rates, lambing rates and multiple births among the groups. The 95% significance level was noted. Statistical Package for Social Sciences (SPSS version 10, 1999) was used for all statistical analysis. Decision tree analysis was draw and computed by using Insight Tree software (Ruegg and Carpenter, 1989) to determine the best economical and profitable program that used in estrus synchronization. The decision tree model in ewes was used to determine the expected return of the decisions to use eCG or eCG plus $PGF_2\alpha$.

Results

No intravaginal sponges were lost during the experiment and none of the ewes showed estrus while the sponges were in place.

Table (2) shows the effect of breeds and $PGF_2\alpha$ administration on reproductive parameters in ewes. The overall estrus response was slightly higher in ewes that treated with eCG+$PGF_2\alpha$ than those received eCG only (100 vs. 97.22%, respectively). Among ewes that treated with eCG only,

estrus response was significantly higher in Ossemi and Rahmani than in Cross breed. However, administration of eCG plus $PGF_2\alpha$ had similar effect on estrus response among local and cross breeds.

Estrus were detected at 32 h after removal of the sponges, generally, administration of eCG plus $PGF_2\alpha$ had better effect on onset of estrus at first 32 h than groups treated with eCG only (59.38% vs. 57.14%, respectively). In addition, the breed type had marked effect on the onset of estrus at first 32 h. In Rahmani and crossbred ewes, interval to onset of estrus at first 32 h was significantly higher than in Ossemi ewes in both treatments. Moreover, the highest response to eCG plus $PGF_2\alpha$ administration was detected in Rahmani breed (75%) at 32 h after removal of the sponges. On the contrary, onset of estrus percent at 32 – 48 h after sponge removal was significantly higher in Ossemi ewes than in Rahmani and crossbred ones in both treatments (Table 2). All animals were come in estrus after 48 h from the removal of the sponges.

The overall pregnancy rates were 94.29% (33/35) in ewes that received eCG only and 84.38% (27/32) in ewes that received eCG plus $PGF_2\alpha$. The highest pregnancy rate was recorded in the crossbred groups (100%, $P<0.001$) and the lowest pregnancy rate was observed in the Rahmani group that received eCG plus $PGF_2\alpha$ (75%, $P<0.001$) as shown in Table 2.

The lambing rate for all groups was 100% (Table 2). No significant differences in the term of the lambing rate were recorded among groups under effects of eCG and eCG plus $PGF_2\alpha$ administration or breed types.

The overall mean number of lambs born per ewes lambing was 1.57±0.10 and 1.52±0.11 for eCG and eCG plus $PGF_2\alpha$ administration, respectively. However, litter size within breeds was significantly higher in crossbred ewes treated with $PGF_2\alpha$ in comparison with local breeds ($P<0.01$, Table 3). No significant differences were recorded in litter size between breeds under effect of eCG. The percentage of multiple births was higher in eCG groups in compared with eCG plus $PGF_2\alpha$ groups in general (63.64%, 55.56%, respectively). Rahmani ewes treated with eCG had greater percentage of multiple births than Ossemi and crossbred ewes ($P<0.05$). However, administration of eCG plus $PGF_2\alpha$ increased multiple births in crossbred ewes in comparison with local breeds ($P<0.01$).

Table (4) demonstrates the economic analysis of two estrus synchronization programs. The expected monetary value (EMV) of estrus synchronization program resulted from using eCG was higher than eCG plus $PGF_2\alpha$ administrations (145.45 US$, 139.68 US$, respectively). Moreover, the estimated economic efficiency of estrus synchronization programs was higher

Table 2: Effect of breeds and $PGF_2\alpha$ administration on estrus response, onset of estrus, pregnancy rate and lambing rate in ewes:

Items/Treatments	Breeds			*P*-value	Average of groups†
	Ossemi	Rahmani	Crossbred		
Estrus response(%):					
eCG	100 (15/15)	100 (12/12)	88.89 (8/9)	***	97.22 (35/36)
eCG + PGF2α	100 (10/10)	100 (12/12)	100 (10/10)	NS	100.0 (32/32)
Onset of estrus (%):					
at 1st 32 h					
eCG	53.33 (8/15)	58.33 (7/12)	62.50 (5/8)	**	57.14 (20/35)
eCG + PGF2α	50 (5/10)	75.0 (8/12)	60.0 (6/10)	***	59.38 (19/32)
at 32 – 48 h					
eCG	46.67 (7/15)	41.67 (5/12)	37.50 (3/8)	*	42.86 (15/35)
eCG + PGF2α	50.00 (5/10)	25.0 (3/12)	40.0 (4/10)	***	37.50 (12/32)
Pregnancy rate (%):					
eCG	93.33 (14/15)	91.67 (11/12)	100.0 (8/8)	***	94.29 (33/35)
eCG + PGF2α	80.00 (8/10)	75.0 (9/12)	100.0 (10/10)	***	84.38 (27/32)
Lambing rate (%):					
eCG	100.0 (14/14)	100.0 (11/11)	100.0 (8/8)	NS	100.0 (33/33)
eCG + PGF2α	100.0 (8/8)	100.0 (9/9)	100.0 (10/10)	NS	100.0 (27/27)

†Means in the same column were non significant (P>0.05).*significant difference at *P*<0.05.
**significant difference at *P*<0.01. ***significant difference at *P*<0.001. NS: non-significant

Table 3: Effect of breeds and PGF_2á administration on litter size, multiple births and pregnancy period in ewes

Items/Treatments	Breeds			*P*-value	Average of groups[†]
	Ossemi	Rahmani	Crossbred		
Litter size:					
eCG	1.57±0.15	1.33±0.19	1.80±0.18	NS	1.57±0.10
eCG + PGF2α	1.50±0.20[ab]	1.18±0.17[b]	1.88±0.20[a]	**	1.52±0.11
P-value	NS	NS	NS		NS
Multiple births (%)					
eCG	64.29 (9/14)	72.73 (8/11)	50.00 (4/8)	*	63.64 (21/33)
eCG + PGF2α	50.00 (4/8)	33.33 (3/9)	80.00 (8/10)	**	55.56 (15/27)
P-value	NS	NS	NS		NS

[†]Means in the same column were non significant (P>0.05).*significant difference at $P<0.05$.
**significant difference at $P<0.01$. NS: non-significant

in eCG than eCG plus PGF_2á program (4.43 vs. 3.94 respectively, Fig. 1).

According to Fig. (2), using of eCG administration program had maximum final profitability (157.14 US$) at the first node (estrus node). On the other hand, administration of eCG plus PGF_2á administration had minimum final profitability (144.64 US$) at the opposite node. Moreover, the decision tree analysis revealed that the application of eCG program was profitable than eCG plus $PGF_2\alpha$ administration. As, at the 2nd node (pregnancy node) the profitability and pregnancy rate were higher (161.63US$, 94.29%) in case of eCG program in contrast to eCG plus PGF_2á administration (144.64US$, 84.39%). Furthermore, the economic success of eCG program was 92%.

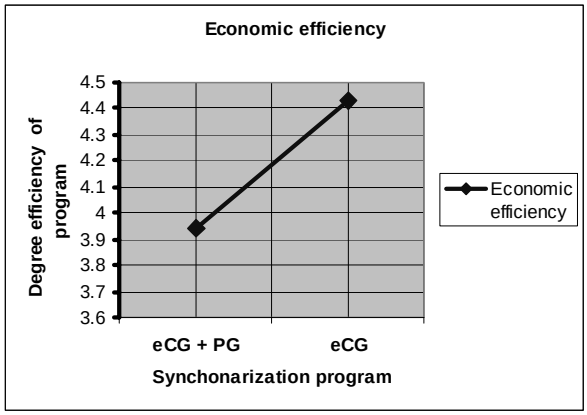

Fig. 1: Economic efficiency of two estrus synchronization programs

Table 4: Payoff of estrus synchronization programs in ewes

Estrus synchronization program	Program's cost (US$)	Program's return (US$)		Expected monetary value (US$)
		High multiple birth	Low multiple birth	
eCG	32.8 $	(P=0.6364) 171.42 $	(P=0.3636) 100 $	145.45 $
eCG + $PGF_2\alpha$	35.4 $	(P=0.5556) 171.42 $	(P=0.4444) 100 $	139.68 $

P= Probabilities of results

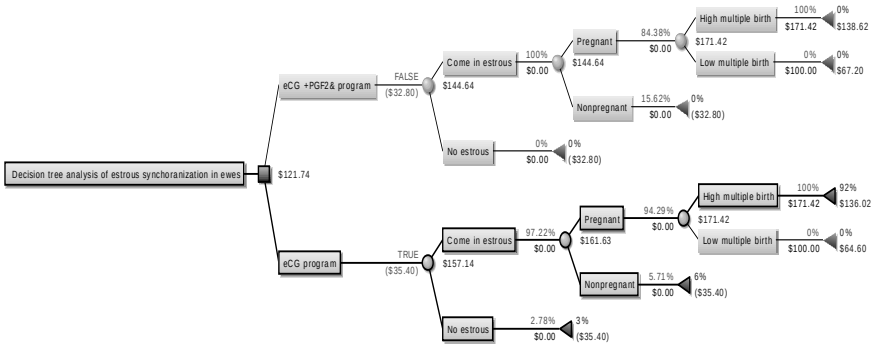

Fig. 2: Decision tree analysis of different events of estrus synchronization programs and their profitability (US$)

Discussion

Estrus synchronization in farm animals is based on manipulating the luteal phase of the estrus cycle to maintain proper breeding records. Subsequently, the luteal phase can either be abruptly terminated by exogenous prostaglandins or it can be extended by exogenous progestins. Therefore, successful protocol to manipulate this phase must not only provide tight synchrony of estrus but also has acceptable fertility rates (Khan *et al.,* 2006).

This study investigates the effect of ewe breed type, eCG and PGF_2á administrations on the response of local and crossbred ewes. The decision on success of each program is judged by the percentage of estrus occurrence, lambing rate as well as economic efficiency of program. In the present study, no ewes exhibited estrus while the intravaginal sponges were in place. Therefore, it can be accepted that the dose of progesterone in the FGA sponges absorbed from the vagina during treatment was sufficient to suppress the preovulatory secretion of pituitary gonadotropins (Moeini *et al.,* 2007). The hormonal treatments either eCG or eCG plus PGF_2á had a similar effect in inducing estrus in both Ossemi and Rahmani (100%). However, PGF_2á was effective in inducing estrus in crossbred ewes. These results agree with Turk *et al.,* (2007) who recorded 100% estrus response due to prostaglandin administation at the time of intravaginal sponge removal. In addition, the percentage of onset of estrus was higher (62%) in crossbred ewes that treated with eCG than local breeds at 32 h after sponge removal. At the same time, the percentage of onset of estrus was improved to 75% in Rahmani ewes at 32 h after sponge removal when eCG plus $PGF_2\alpha$ is used. Therefore, administration of eCG plus $PGF_2\alpha$ on the day of sponge removal

shorten the interval to estrus especially in Rahmani breed (Titi *et al.*, 2009).

In the present study, the overall pregnancy rate was 94.29% and 84.38% for eCG and eCG plus $PGF_2\alpha$ treatments respectively ($P>0.05$). Within the breeds, the highest pregnancy rate (100%) was recorded in crossbred groups treated either with eCG or eCG plus $PGF_2\alpha$. However, the lowest pregnancy rate was reported in the Rahmani groups that received eCG or eCG plus $PGF_2\alpha$ (91.67 and 75%, respectively). These results were comparable to previous studies (Timurkan and Yildiz, 2005; Nasroallah *et al.*, 2012). This difference in pregnancy rate among groups might be attributed to the reproductive status of the ewes, the type of insemination (natural or artificial insemination) and the season of the year.

In this study, the lambing rate was 100% in all groups and breeds without influence of the breed or the method of synchronization on the lambing rate. This finding was in agreement with 100% (Abuzer *et al.*, 2011) and higher than 48.9% (Moeini *et al.*, 2007). This difference in lambing rate may be attributed to many causes as accident, certain diseases or the reproductive status of the ewes.

Crossbred ewes had a better response to eCG plus $PGF_2\alpha$ administration (as evident by the greater litter size and multiple births), which may indicate a possible genetic difference between local and foreign ewes that can be improved the local breeds by crossing. Genetic differences between breeds have been shown to affect the twinning rate in hormonally treated ewes (Emsen and Yaprak, 2006).

The percentages of multiple births were 72.73% and 80.00% in Rahmani ewes treated with eCG and crossbred ewes received eCG plus $PGF_2\alpha$, respectively. Yavuzer (2005) reported that the percentage of multiple births in non-hormonally treated Awassi ewes under intensive management conditions is about 10%. Even though $PGF_2\alpha$ administration is effective in inducing estrus and an improvement in fecundity in crossbred ewes, its effect on the percentages of multiple births in local breeds is limited. Thus, the higher twinning rate obtained in crossbred ewes (most probably due to inherent factors) clearly indicates their superiority over local breed ewes in terms of reproductive performance.

The estimated economic efficiency of estrus synchronization programs was higher in eCG than eCG plus $PGF_2\alpha$ program (4.43 vs. 3.94 respectively). This indicated that eCG is more efficient than eCG plus $PGF_2\alpha$. Moreover, decision tree analysis revealed that, the application of eCG program was profitable than eCG plus $PGF_2\alpha$ administration as, using of eCG administration program made maximum final profitability (157.14 US $) but, administration of eCG plus $PGF_2\alpha$ administration made minimum final

profitability (144.64 US $). Therefore, using of eCG and PGF2á injection probably increases the cost of production of lambs (Anilkumar *et al.*, 2010).

Conclusion

Crossbred ewes had a better reproductive response to prostaglandin administration than local breed ewes. However, Rahmani ewes responded better to eCG than Ossemi and crossbred ewes. Injection of eCG was more profitable than eCG plus $PGF_2\alpha$ administration through increasing mean litter size and multiple births during the breeding season.

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