Using Progesterone and Prostaglandin $F_{2\alpha}$ for Ewes Estrus Synchronization during Summer Season in Egypt

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Abstract: This study was carried out to investigate the effect of administration of progesterone (P4) and prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) hormones on ewe estrus synchronization during summer season in Egypt. The study was performed on thirty four non-pregnant or lactating local ewes, 2 - 4 years old and 42.1 ± 1.8 kg average live body weight. Ewes were randomly divided into three groups as follows: natural estrus (control n = 10), intervaginal progesterone sponges (P4 = 12 ewes) for 12 days and two injections of $PGF_{2\alpha}$ (12 ewes) 12 days apart. Parameters of estrus, conception and body weight of lambs were measured. Results showed that the percentage of estrus signs exhibition in $PGF_{2\alpha}$ group reached 83.3%, while the lowest percentage (60%) was observed in control group ($P<0.05$). The time of starting estrus was earlier ($P<0.05$) in $PGF_{2\alpha}$ and P4 groups (44.8 and 46h, respectively) than that in control group (58.4 h). The estrus duration was significantly longer ($P<0.05$) in $PGF_{2\alpha}$ and P4 groups (44 and 41.6 h, respectively) than control group (31.2 h). The percentages of pregnant and lambing rates were 100% in all animals came to heat in all groups. While pregnancy rates and lambing rates according to initial number used were 83.3, 75% and 60% for $PGF_{2\alpha}$, P4 and control groups ($P<0.05$), respectively. The litter size, birth weight and weaning weight of lambs born did not differ significantly among groups. Weaning rate was the highest ($P<0.05$) in $PGF_{2\alpha}$ group (92.9%) and the lowest in P4 group (85.7%). The percentage of ewes lambed twins was the highest ($P<0.05$) in P4 group (56%) and the lowest percentage in control group (33%). The percentage of male lambs was the highest ($P<0.05$) for ewes in $PGF_{2\alpha}$ group (57.1%) and the lowest for ewes in control group (37.5%). In conclusion, $PGF_{2\alpha}$ and P4 protocols could adequately induce estrus synchronization and improve some reproductive and productive traits in local ewes during summer season in Egypt. Further studies are recommended to proof results using more number of ewes.

Keywords: Estrus Synchronization, P4, $PGF_{2\alpha}$, ewes

INTRODUCTION

Reproductive activity in sheep varies according to the seasonal changes (Gibson and Robinson, 1971). Seasonal changes in reproduction can be observed by changes in the proportion of females showing sexual receptivity (Knights *et al*., 2002). Also, Huston (1983) reported that the twining and fertility rate were increased in winter than summer. This necessitates applying a synchronization procedure to overcome this phenomenon. Estrus synchronization is a technique used to bring large number of animals in a flock into overt heat at the predetermined time (Panhwar, 2007). Hormonal treatment to control ovulation and reproduction is a perquisite for successful breeding and increasing the number of pregnant females (Motlomelo *et al*., 2002; Husein *et al*., 2005), conception rate and poor fertility especially under semiarid conditions (Husein and Kridli, 2003). Progestagen-based protocols are commonly used worldwide (Abecia *et al*., 2012). In numerous studies on small ruminants a high degree of estrus synchronization with the use of progestagen sponges (khalifa, 1993; Simonetti *et al*., 2002; Dogan and Nur, 2006). Prostaglandin$F_{2\alpha}$is one of its analoges causes luteolysis in sheep having a functional corpus luteum at the time of treatment (khalifa, 1993; Turk *et al*., 2008). Double $PGF_{2\alpha}$ injections are common for estrus synchronization in ewes (khalifa, 1993; Ataman *et al*., 2005; Zeleke *et al*., 2005). Progestagen-based protocols have the potential for environmental contamination because of the residual P4 in devices and the addition of antibiotics to avoid vaginitis (Ataman and Akoz, 2006; Vinoles *et al*., 2011; Oliveira *et al*., 2015). Moreover, the progestagen sponges are expensive. However, using $PGF_{2\alpha}$ and/or its analogues are a good alternative, because they are rapidly metabolized in the lung and therefore, not accumulated in tissues (Davis *et al*., 1980). Therefore, the present study aimed to investigate the effect of administration of P4 and $PGF_{2\alpha}$ hormones on estrus synchronization in ewes during summer season in Egypt, and determining some reproductive and productive traits in estrus synchronized ewes.

MATERIALS AND METHODS

This study was carried out at the Animal Production Farm in Ismailia Research Station, Animal Production Research Institute during summer season (July, 2019) (latitude 31°E and longitude 32°N). Thirty-four non-pregnant and non-lactating local ewes with 2-4 years old and 42.1±1.8 kg average live body weight were used. Ewes were housed in semi-open pens. The same feeding conditions (NRC, 1985) were applied to all animals. Animals were raised at the same environmental condition in pens. Ewes were randomly divided into three groups as follows: Control group (n=10): natural estrus occurring, P4 group (P4 = 12 ewes): intervaginal sponge of progesterone and $PGF_{2\alpha}$ group (12 ewes): injection of $PGF_{2\alpha}$. The ewes P4 intervaginal sponges containing 40 mg of flugestone acetate (Syncrite-40, Australia), were left in the vagina for 12 days. In ewes of $PGF_{2\alpha}$ were intramuscularly injected with two injection of $PGF_{2\alpha}$ (1 ml Estromate, 250 mg Cloprostenol, Coopers Co., Germany) 12 days apart.

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Ewes were chocked for estrus signs for three times daily. Three fertile rams were introduced to the ewes in each group (one ram per 4 ewes) for estrus detection and mating; starting at the sponge withdrawal day in P4 group and after second injection of $PGF_{2\alpha}$ in the morning and evening for 5 consecutive days. Estrus signs rate was calculated as the number of ewes showed signs of estrus per total ewes. The time of starting estrus was defined as the time between sponges removal or after second injection of PGF2α and the first accepted mount of the ewes was recorded. While in control group was recorded the time from 15 day after the last estrus and the first accepted mount of the ewes. Estrous duration was calculated as the time between the first and last accepted mount. Thirty days after successful last mating, ewes were examined for pregnancy by using ultrasound scanner (Honda HS-1500V, Honda Electronics, Japan). Conception rate calculated as the number of ewes conceived per initial number of ewes used. Gestation period was defined as the time between successful last mating and the parturition. The lambing rate was calculated as the number of ewes lambed per initial number of ewes used. Litter size was calculated as the number of total lambs born per number of ewe lambed. The body weights of lambs were weighed at birth and at weaning (120 days). The lambs were fasted overnight before weighing at 8.00 a.m. Weaning rate was calculated as number of lambs live at weaning per number of lambs born. Birth types (twins and single) and sex ratio (male and female) of lambs were recorded immediately after kidding.

Data were subjected to statistical analysis by using SPSS (2011) program. Differences among treatment means were tested for significance ($p<0.05$) using Duncan' multiple range test (Duncan, 1955).

The mathematical model is:

Yij = μ + Ti + eij

Where:

Yij = Individual observation

μ = The overall mean for the trial under consideration

Ti = The effect of the i treatments

eij = Random residual error

RESULTS

Estrus signs rate, the time of starting estrus, estrus duration, pregnancy rate, lambing rate, litter size and gestation length are shown in Table (1). The percentage of estrus sings exhibition in $PGF_{2\alpha}$ group reached 83.3% ($P<0.05$) and in P4 group was 75%, while the lowest percentage (60%) was observed in control group. The time of starting estrus was significantly early ($P<0.05$) in treated groups than that of control group. The estrus duration was significantly longer ($P<0.05$) in treated groups than that of control group. The pregnancy and lambing rates were 100% in all ewes showed estrus in all groups, While pregnancy rate showed significant ($P<0.05$) differences between groups when calculated from the initial number used in each group. Estrus synchronization methods were significantly ($P<0.05$) raised the pregnancy rate in treated groups than that in non-treated (control group). The same trend and result was observed in lambing rate. There were no significant differences in the litter size among the three groups. It was 1.6 in P4 group, followed by 1.4in $PGF_{2\alpha}$ group and 1.3 in the control group. The gestation length showed about one day longer in P4 group than control and $PGF_{2\alpha}$ groups.

Table (1): Estrus signs rate of ewes and reproductive parameters of treated and control groups (mean ± SE)

Items	**Control (10)**	**P4 (12)**	**$PGF_{2\alpha}$ (12)**
No. of ewes showed estrus	6	9	10
Estrus sings rate (%)	60^{c} (6/10)	75^{b} (9/12)	83.33^{a} (10/12)
Time of starting estrus (h)	$58.40^{a} \pm 2.85$*	$46.00^{b} \pm 2.60$	$44.80^{b} \pm 2.85$
Estrus duration (h)	$31.20^{b} \pm 2.88$	$41.60^{a} \pm 2.88$	$44.00^{a} \pm 2.63$
Pregnancy rate (%)	60^{c} (6/10)	75^{b} (9/12)	83.33^{a} (10/12)
Pregnancy of mated ewes (%)	100 (6/6)	100 (9/9)	100 (10/10)
Lambing rate (%)	60^{c} (6/10)	75^{b} (9/12)	83.33^{a} (10/12)
Lambed ewes of pregnant ewes (%)	100 (6/6)	100 (9/9)	100 (10/10)
Litter size	1.3 ± 0.15 (8/6)	1.6 ± 1.14 (14/9)	1.4 ± 0.14 (14/10)
Gestation length (days)	150. 42 ± 0.50	151.83 ± 0.47	150.10 ± 0.42

* The time from15 day after the last estrus and the first accepted mount of the ewes

[a,b,c] in the same row with different superscripts are significantly different ($P<0.05$)

Table (2) shows birth weight, weaning weight, weaning rate, type of lambing of ewes and sex ratio of newborn lambs of control and estrus synchronized ewes. No significant differences in birth weight and weaning weight were found among the three groups. However, there was a trend of higher values in hormonally treated groups than that in control group on the previous parameters as (3.03 kg and 12.70 kg, respectively) in P4 group and (2.97 kg and 12.66 kg, respectively) in $PGF_{2\alpha}$ group. Weaning rate was the highest (P<0.05) in $PGF_{2\alpha}$ group (92.9%) and the lowest in P4 group (85.7%). The percentage of ewes lambing twins was the highest (P<0.05) in P4 group (56%) and the lowest in control group (33%). Their counterparts of lambing single percentage was the highest (P<0.05) in control group (67%) and the lowest value in P4 group (44%). In addition, the percentage of male lambs was the highest (P<0.05) for ewes in $PGF_{2\alpha}$ group (57.1%) and the lowest for ewes in control group (37.5%). Their counterparts of female lambs percentage was the highest (P<0.05) for ewes in control group (62.5%) and the lowest for ewes in $PGF_{2\alpha}$ group (42.9%).

Table (2): Productive parameters of control and estrus synchronized ewes (mean ± SE)

Items	Control	P4	$PGF_{2\alpha}$
Birth weight (kg)	2.96 ± 0.08	3.03 ± 0.05	2.97 ± 0.05
Weaning weight (kg)	12.49 ± 0.25	12.70 ± 0. 15	12.66 ± .015
Weaning rate (%)	87.5^{b} (7/8)	85.7^{c} (12/14)	92.9^{a} (13/14)
Type of lambing:			
Single (%)	67^{a} (4/6)	44^{c} (4/9)	60^{b} (6/10)
Twins (%)	33^{c} (2/6)	56^{a} (5/9)	40^{b} (4/10)
Sex of newborn			
Male (%)	37.5^{c} (3/8)	43^{b} (6/14)	57.1^{a} (8/14)
Female (%)	62.5^{a} (5/8)	57^{b} (8/14)	42.9^{c} (6/14)
Sex ratio (female/male)	1.7	1.3	0.75

^{a,b,c} in the same row with different superscripts are significantly different (P<0.05)

DISCUSSION

The current results showed successful estrus synchronization methods used in local ewes during summer season. The percentage of estrus signs rate exhibition in $PGF_{2\alpha}$ group reached 83.3% and in P4 group was 75%, while it was 60% in control group. These findings were agreeable with Greyling and Van der Nest (2000), Motlomelo *et al*. (2002) and Naderipour *et al*. (2012) reported that the range of estrus signs rate in sheep was 51.7 to 87.5% using intravaginal progestagen sponges during the breeding and non-breeding season. Mutiga and Mukasa-Mugerwa (1992) and Ataman and Aköz (2006) found that estrus signs rate was 83% after double injection of $PGF_{2\alpha}$. Also, Abu El-Ella *et al.* (2016) found that the estrus signs rate was 86.7% in ewes treated by medroxyprogesterone acetate (MAP) + equine chorionic gonadotropin (eCG) and 60% in non-treated ewes during summer season. While the estrus signs rate determined in our study was little lower than that reported by Abdel-Mageed (2006), Akoz *et al.* (2006), Ozyurtlu *et al.* (2010), Pietroski *et al*. (2013) and Gardón *et al*. (2015) following sponge treatment. Öztürkler *et al.* (2003) and Abdalla *et al.* (2014) reported that estrus signs rate was 90.2 and 100% after double injection of $PGF_{2\alpha}$, respectively. Zeleke *et al*. (2005), Kareta *et al.* (2006), Kausar *et al*. (2009) and McCappin and Murray (2011) reported that variations in estrus signs rate could be attributed to age, parity, nutrition, breed, location and time of the year, climate changes and type of hormones. The time of starting estrus varied between treatments and occurred within 24 - 144 h following progestagen or progesterone withdrawal (Simonetti *et al*., 2000; Vinoles *et al*., 2001). In addition, Dogan and Nur (2006) recorded that ewes came to heat between 18 and 96 h after sponge withdrawal, with the highest incidence of estrus occurring between 30 and 60 h. The time of starting estrus in the present study lied through the previous reported research data. Moreover, our results showed that the time of starting estrus was earlier in P4 and $PGF_{2\alpha}$ groups (46 and 44.8 h, respectively) than that in control group (58.4 h). The time of starting estrus in our study were lower than that reported by Didarkhah and Mesgaran (2013), Jackson *et al*. (2014) and Gardón *et al*. (2015) who found that the time of starting estrus was 60, 60 and 55 h in ewes treated with P4, respectively. In another study, Abu El-Ella *et al*. (2016) found that the time of starting estrus was 52.8 h using MAP + eCG during summer season. These results were higher than that reported by Almadaly *et al.* (2016) who found that time of starting estrus was 37.3 and 24 h with using P4 and $PGF_{2\alpha}$, respectively. Estrus duration (estrus period) was classified to be short (less than 25 h), normal (25-40 h) and long (more than 40 h) according to Deghady (2000). These differences may be explained by differences in breed, lactation, nutrition, season and gonadotropins or progestagen treatments (Romano, 2002 and Omontese *et al*., 2010). In the present study, the estrus duration was significantly longer (44 h) in $PGF_{2\alpha}$ and P4 groups (41.6 h) than that in control group

(31.2 h). Also, Abu El-Ella *et al*. (2016) found that estrus duration was 45.6 h, which was longer in hormonal treated ewes (MAP + eCG) than 24 h in the control group. Most of the recent developments in reproductive techniques have to use some hormones. Moreover, EL-Sherry *et al*. (2012) found that high pregnancy rates and litter size with using progesterone based in synchronized programs. Also, Yadi *et al*. (2011) showed that progestogens and $PGF_{2\alpha}$ increased the conception rate in ewes. P4 and $PGF_{2\alpha}$ either alone or in combination would be good techniques to improve reproductive performance and fertility (Loubsera and van Niekerka, 1981). All synchronization protocols had a positive effect on ewe fertility during the non-breeding season (Almadaly *et al*., 2016). In our study, the pregnancy and lambing rates were 100% in all ewe came in estrus. This result agreed to results obtained by Jawad (2014) who found that the lambing rate of ewes treated by sponges was 100%. In the present study, calculating pregnancy rate values according to initial number of animals in each group showed that in $PGF_{2\alpha}$ group (83%), in P4 group (75%) and in control group (60%). Almadaly *et al*. (2016) found that conception and lambing rates in ewes treated by P4 + eCG were 44% and 100% in ewes treated by $PGF_{2\alpha}$+ eCG. Gardón *et al*. (2015) found that pregnancy rate was 71.4% in ewes treated by MAP. Abdalla *et al*. (2014) found that the pregnancy and lambing rate were 95% in ewes treated by $PGF_{2\alpha}$. Also, Yadi *et al*. (2011) showed that pregnancy rate in ewes treated by sponges and $PGF_{2\alpha}$ were 45 and 70%, respectively. On other studies, the conception rates in ewes treated by intra-vaginal sponges + eCG injected at time of sponge removal were 96.8% (Wildeus, 2000) and 100% (Huseyin and Yildiz, 2005; Akoz *et al*., 2006). Also, the lambing rates were 85.7% (Akoz *et al*., 2006), 75.6% (Koyuncu and Alticekic, 2010), 93.3% (Kulaksiz *et al*., 2013) and 100% (Abdalla *et al*., 2014; Abu El-Ella *et al*., 2016). This discrepancy in the results reported by different researchers on pregnancy and lambing rate can be explained by the differences in body condition, breed, and management systems. Litter size is considered an important factor in the development of sheep production. Increasing litter size rates in sheep offers the best opportunity to increase the efficiency of lamb meat production. In our study, there were no significant differences in the liter size among the three groups. However, it was the highest (1.6) in P4 group and the lowest (1.3) in the control group. This result was similar to results obtained by Abdel-Megeed (2006) who found that litter size at birth was 1.3 in ewes treated with $PGF_{2\alpha}$ and no significant differences between treated and not treated ewes. Also, Horoz *et al*. (2003) found that litter size at birth was 1.4 in ewes not hormonally treated. The litter size at birth in our study was higher than that reported by Gardón *et al*. (2015) who found that litter size was 1.4 in ewes treated by MAP sponges and Abu El-Ella *et al*. (2016) who found that litter size was 1.1 in not treated ewes. Safdarian *et al*. (2006) and Abdalla *et al*. (2014) found that litter size was 1.3 and 1.1 in ewes treated by $PGF_{2\alpha}$, respectively. Whereas, litter size was lower than that reported by Cruz *et al*. (1991) who found that litter size was 1.6 in ewes not treated. In the present study, the gestation period showed about one day longer in P4 group (151.8 days) than control and $PGF_{2\alpha}$ groups (150.4 days and 150.1 days, respectively). These results in agreement with those reported by Domingues *et al*. (1991) who found that the range of pregnancy period in ewes treated by sponges was reported from 144 days to 152 days. Also, Aboul-Ella (2006) reported that length of gestation period was shorter in ewes treated with PG in Barki ewes. Moreover, Zarkawi (2000) reported that the treatment had no effect on the duration of pregnancy, which averaged 150.3 days in control and 150.4 and 150.8 days in synchronized groups with 10 and 15 mg PGF2α, respectively. Whereas, pregnancy period in the present study was lower than that reported by Farrag (2019) who found that the average gestation length period were 157.37 and 154.88 days for control ewes and $PGF_{2\alpha}$ ewes, respectively in Abou-Delik ewes grazing in the South Eastern zone of Egypt. Also, Safranski *et al*. (1992) who found that pregnancy periods in control ewes and ewes treated with melengesterol acetate (MGA) + PG-600 were 163.8 and 157.2 days, respectively in Kalkuhi ewes in Iran. Horoz *et al*. (2003) reported that gestation periods in control ewes and those treated with medroxyprogesteron were 164 days and 155 days, respectively in Kivircik ewes in Turky. This difference can be likely due to the different breed of sheep and the environment. Body weight is considered to be a good indicator of the reproductive performance (Shetaewi *et al*., 2001). Birth and weaning weights are important criteria in meat production because of their high correlation with growth rate and adult size (Al Shaikh *et al*., 1989). In our study, no significant differences in birth weight and weaning weight among the three groups. However, it was the highest in P4 group and the lowest in the control group. These results were in agreement with those results obtained by Abu El-Ella *et al*. (2016) who found that birth weight was high in the treated groups than control group. Whereas, birth weight in present study was lower than that results reported by Abdel-Megeed (2006) which was 3.7 kg and Lethy *et al*. (2003) which was 3.5 kg in ewes treated by $PGF_{2\alpha}$. In present study weaning rate was significantly higher in $PGF_{2\alpha}$ group than the other groups. These results were in agreement with result optioned by Farrag *et al*. (2010) who found that the weaning rate was 90% in ewes treated with two doses of $PGF_{2\alpha}$. In our study, the percentage of ewes lambed twins was the highest in P4 group (56%) and the lowest in control group (33%). This result was similar to that was found by Ezzat *et al*. (2017) who found that the incidence of twining rate in ewe treated by 300 mg P4. Also, Abu El-Ella *et al*. (2016) found that the percentage of lambing single was higher in control than in MAP + eCG ewes.

CONCLUSION

In general, using of P4 and $PGF_{2\alpha}$ protocols were successful in inducing estrus synchronization of local ewes in terms of estrus signs rate, estrus duration, pregnancy and lambing rates compared to non-treated group. In addition, results indicated improving the productive and reproductive performance of local sheep by applying estrus synchronization methods during summer season in Egypt.

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استخدام البروجسترون والبروستاجلاندين $F_{2\alpha}$ في تزامن الشياع في الأغنام المحلية خلال فصل الصيف في مصر

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أجريت هذه الدراسة لمعرفة تأثير استخدام هرمونات البروجستيرون والبروستاجلاندين $F_{2\alpha}$ على تزامن الشياع في فصل الصيف في مصر، ومقارنة استخدام هذه الهرمونات في إحداث تزامن الشياع مع الشبق الطبيعي في النعاج. تم استخدام أربعة وثلاثين نعجة محليه غير مرضعة وغير عشار أعمارهم ما بين ٢-٤ سنه وبمتوسط وزن حي ٤٢.١±١.٨٠ كجم. تم تقسيم النعاج بشكل عشوائي إلى ثلاث مجموعات: مجموعه الشياع الطبيعي (المجموعة غير المعاملة، ن = ١٠)، مجموعه الإسفنجات (P4=١٢) لمدة ١٢ يومًا ومجموعه البروستاجلاندين $F_{2\alpha}$ (١٢ نعجة) بمعدل حقنتين بفارق زمني ١٢ يومًا. تم قياس معدلات الشبق والحمل وأوزان المواليد. أظهرت النتائج أن نسبة الاستجابة للشبق في النعاج المعاملة البروستاجلاندين $F_{2\alpha}$ بلغت ٨٣.٣٪ في حين لوحظ أن أقل نسبة (٦٠٪) في المجموعة غير المعاملة (**P<0.05**). وكانت اقصر فتره للشياع المتوقع (P<0.05) في مجموعات P4 والبروستاجلاندين F2α (٤٦ و ٤٤,٨ ساعة على التوالي) عن المجموعة غير المعاملة (٥٨,٤ ساعة). في حين كانت مدة الشبق أطول معنويا (**P<0.05**) في مجموعات البروستاجلاندين F2α و P4 (٤٤ و ٤١,٦ ساعة على التوالي) عن المجموعة غير المعاملة (٣١,٢ ساعة). وكانت معدلات الحمل والولادة ١٠٠٪ في جميع المجموعات. بينما كانت معدلات الحمل والولادة المنسوبة إلى الأرقام الأولية المستخدمة ٨٣٪ و ٧٥٪ و ٦٠٪ للمجموعات البروستاجلاندين F2α و P4 والمجموعة غير المعاملة (P<0.05) على التوالي. بينما لا توجد اختلافات معنوية بين المجموعات في معدل المواليد والوزن عند الولادة ووزن الفطام. في حين كان معدل الفطام أعلى معنويا (P<0.05) في مجموعه البروستاجلاندين $F_{2\alpha}$ (٩٢,٩٪) عن المجموعة غير المعاملة ومجموعة P4 (٨٧.٥ و ٨٥,٧٪ على التوالي). وكذلك كانت أعلى معدل التوائم (٥٦٪) في مجموعه البروجسترون وأقل معدل التوائم (٣٣٪) في مجموعه المجموعة غير المعاملة. وأيضا كانت أعلى نسبة للذكور المولودة (P<0.05) في مجموعه البروستاجلاندين $F_{2\alpha}$ (٥٧.١٪) وأقل نسبة للذكور المولودة في المجموعة غير المعاملة (٣٧.٥٪). ومما سبق فإن الدراسة أوضحت أن استخدام البروستاجلاندين $F_{2\alpha}$ والبروجسترون يمكن أن يحسنوا في تزامن الشبق وبعض الصفات التناسلية والإنتاجية في النعاج المحلية خلال موسم الصيف في مصر. ويوصى بإجراء مزيد من الدراسات لإثبات النتائج باستخدام عدد أكبر من النعاج.