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The effect of reduced dose of PGF_{2α} on certain reproductive parameters in awassi yearlings in anestrus synchronization protocol following the end of the breeding season

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ABSTRACT: The aim of this study was to investigate the effect of the administration of half or full dose of prostaglandin F_{2α} (PGF_{2α}; Gestavet Prost, d-cloprostenol, HIPRA®) injection in a routine synchronization protocol following the end of the breeding period including intravaginal sponge (medroxyprogesterone acetate; Espanjovet, HIPRA®) and eCG (Oviser 500, HIPRA®) on certain fertility parameters in ewes. Two hundred thirty-eight Awassi yearlings (aged one year old) divided into two groups: 116 ewes received a half dose (HSDP; 37.5 µg) of PGF_{2α} and 122 ewes received full dose (FSDP; 75 µg). The pregnancy rates were 67.2% and 72.1% for HSDP and FSDP, respectively (P>0.05). The lambing rates were 64.7% and 63.9% for HSDP and FSDP, respectively (P>0.05). The single lambing rate in HSDP (94.7%) was higher (P<0.05) compared to that in FSDP (73.1%). The twin and multiple birth rates of FSDP was higher (P<0.05) than HSDP. As a result, it was inferred that aHSDP could be used in Awassi yearlings without experience of lamb care and in a herd in which single lambing was preferable. Moreover, due to the fact that it is more affordable and not detrimental to fertility, it was concluded that HSDP can offer an advantage in large flocks and can be used for manipulating fecundity rates in yearlings.

Key words: Awassi sheep; sponge; reduced PGF_{2α} dose; end of the breeding season; synchronization

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INTRODUCTION

Rapid growth of the world population and increased nutrient requirements related to this has forced livestock industry to manage animal reproduction consciously and economically. In today's world, sheep breeding has advantages over cattle breeding due to the grazing ability in non-arable land, having short pregnancy duration, providing animal product such as meat, milk and wool. It is important to maximize output with minimum input to make sheep production efficient (Kaymakçı et al., 2009).

The main objective of sheep production in terms of fertility is to achieve three lambings in two years (Alacam, 2010; Bulbul et al., 2014). While the increase in the birth rates provide more profits and sustainability of the sheep production economically, multiple birth rates can accompany with problem such as higher lamb mortality (Binns et al., 2002). There are many risk factors associated with lamb mortality in the ewes such as lamb birth weight, sex, pneumonia, gastrointestinal diseases, season, trauma, poor mothering pen hygiene, starvation, multiple births, maternal behaviour and care of lambs (Huffman et al., 1985; Stevens et al., 2013; Yapi et al., 1990; Gama et al., 1991; Nash et al., 1996; Binns et al., 2002; Bangar et al., 2016).

One of the reasons of the lamb mortality is multiple births (twin and triple birth) (Huffman et al., 1985; Nash et al., 1996; Binns et al., 2002). Twin and triplet born lambs are more prone to starvation due to the poor dam nutrition and reduced colostrum production by the dam (Refshauge et al., 2016). Also, twin born lambs are smaller and showed weakness in sucking enough amount of the colostrum (Flaiban et al., 2009). It was reported that starvation/exposure accounted for the 45 % of mortality for the multiple born lambs (Scales et al., 1986). Parity are also related to neonatal lamb mortality (Gama et al., 1991; Dwyer et al., 2005; Mouse-Balabel, 2010). Higher lamb mortality was observed in the primiparous ewes compared to second parity (Gökçe et al., 2013). This can be resulted from lower birth weight of lambs, poor colostrum quality and delayed expressions of maternal behaviour in the primiparous ewes (Dwyer et al., 2003; Levy and Keller, 2008). Refshauge et al. (2016) reported that mismothering and starvation account for 25 % of the neonatal lamb loss in the sheep production. Therefore, manipulating of the litter size can be advantageous in some circumstances in sheep production.

To date, gonadotrophin hormones such as hCG, eCG and GnRH have been used frequently for controlling the litter size in sheep (Cam et al., 2002; Khan et al., 2003; Karaca et al., 2009; Quintero-Elisea et al., 2011). The high dose of eCG results in multiple ovulations, whereas low dose eCG or protocols without eCG causes lower ovulation rates, consequently higher single birth rates (Mutiga and Mukasa-Mugerwa, 1992; Quintero-Elisea et al., 2011; Nafaji et al., 2014). It was stated that post-mating hCG and GnRH treatment on day 12 increased the twin pregnancy rates without effecting the single pregnancy rates in sheep (Cam et al., 2002; Cam and Kuran, 2004). Although data on effect of gonadotropins on the litter size in sheep are abundant (Cam et al., 2002; Khan et al., 2003; Karaca et al., 2009; Quintero-Elisea et al., 2011), no evidence was found regarding the effect of PGF_{2α} on litter size and studies regarding clinical implication of reduced dose of PGF_{2α} in the sheep reproduction are none.

Based on all this information, the main goal of current study was to reduce the rate of the twin or multiple birth rate in yearling sheep without lamb care experience or in herds in which multiple births are not generally preferred. It was hypothesised that this could be achieved by reducing the dose of PGF_{2α} from a full dose (75 µg) to a half dose (37.5 µg) in the routine synchronization protocol.

MATERIALS AND METHODS

The study was approved by the Office of Animal Ethics Committee of Hatay Mustafa Kemal University (no. 2017/4-4).

Animals

Two hundred thirty eight non-pregnant 45-50 kg weighted Awassi yearlings were chosen from a flock, after the end of breeding period (natural service from August to November) and following pregnancy diagnosis via ultrasonography (USG) (Pie Medical, Falco, Netherlands) 45 days after the removal of the rams. The study was carried out on 22 December 2017 following the end of the breeding period (Akcapınar, 1994). Body condition score was made according to Kenyon et al. (2014). The ewes had an average body condition score of 3 and fed with total mixed ration (TMR). Before ram introduction, flushing was done for 30 days with concentrated feed given as 530 gram/animal. Ingredient of TMR were containing bran (10%), maize (52.3%), barley (23%), yeast (1.3%), dicalcium phosphate DCP (0.5%), cottonseed oil

meal (1.4%), sunflower seed meal (9%), selenium and zinc (1.5%). As roughage, 1050 gram corn silage, 250 gram straw and 450 gram alfalfa were given.

Identifying the number of animals

The number of animals required was determined by taking into consideration previous studies and by sample measurement according to the study hypothesis. Sample measurements are given below in Table 1, according to confidence level, power of study and rates.

Hormones used in synchronization and determination of the dosage of the prostaglandin F_{2α}

Progesterone (Medroxyprogesterone acetate-MPA) containing sponge (60 mg MPA, Espanjovet, HIPRA®, Spain), eCG (500 IU, Oviser, HIPRA®, Spain) and d-cloprostenol (75 µg, Gestavet Prost, HIPRA®, Spain) were used. Protocols used in the present study are given in Table 2.

Alacam (2007) reported that the dose of PGF_{2α} used in sheep can be half of that used in cow for luteolysis. Thus, a full dose of PGF_{2α} for sheep (FSDP) was defined as 75 µg d-cloprostenol by taking into account short product characteristics of Gestavet Prost (d-cloprostenol, 75 µg, HIPRA®) and the dose used for cows for luteolysis (150 µg d-cloprostenol was enough for cows) and 37.5 µg d-cloprostenol defined as half sheep dose (HSDP).

Hormonal applications

Both groups were housed together during natural breeding. On 22 December 2017, breeding was started approximately 12 hours after the sponge removal. Ram:ewe ratio was 1:6 and forty rams were held in the flock for 30 days to cover two consecutive estrus

cycles. Oestrous behaviours and breedings were not recorded. Pregnancy diagnosis was done via USG with a convex ultrasound transducer (Pie Medical Falco, 2- 5 MHz Convex Probe) at the 45th days after ram's removal (Padilla-Rivas et al., 2005; Suguna et al., 2008). Pregnancy staging was made by determining the ossification in the head, ribs and vertebrae (Ali and Hayder, 2007). Pregnancy records, lamb mortality rate at birth and litter size were recorded.

Fertility parameters

Fertility parameters of animals in the groups were measured with the formulas below.

Pregnancy rate (%) = (Number of pregnant ewes / Total number of ewes) x 100

Lambing rate (%) = (Number of ewes lambing / Number of pregnant ewes) x 100

Single birth rate (%) = (Number of ewes delivered single lamb / Number of ewes delivered) x 100

Twin birth rate (%) = (Number of ewes delivered twins / Number of ewes delivered) x 100

Multiple birth rate (%) = (Number of ewes delivered multiple lambs / Number of ewes delivered) x 100

Fecundity rate (%) = (Number of lambs born / Number of ewes delivered) x 100

Lamb mortality rate at birth (%) = (Number of lambs died / Number of lambs born) x 100

Statistical analysis: A comparison of analysed fertility parameters of sheep in groups was made with the SPSS® 22.0 (IBM Corporation, New York NY, USA) program with chi-square (X²) analysis test.

Table 1. Number of animals in study groups

Rate 1	Rate 2	Confidence level	Power	Sample Size (per group)
0.67	0.53	0.90	0.8	124
0.67	0.52	0.90	0.8	109

Table 2. Protocols with half (HSDP) or full (FSDP) dose of PGF_{2α}

Groups	Protocol	Number of animals
HSDP Group	MPA sponges for 7 days + 500 IU eCG and 37.5 µg d-cloprostenol i.m. at sponge removal + natural service by ram introduction on 12 h after sponge removal	116
FSDP Group	MPA sponges for 7 days + 500 IU eCG and 75 µg d-cloprostenol i.m. at sponge removal + natural service by ram introduction on 12 h after sponge removal	122

Table 3. Fertility parameters of ewes received half (HSDP) or full (FSDP) dose of PGF_{2α} during a 7 days synchronization protocol with MAP plus eCG (%; n)

Fertility Parameters% (n)	HSDP (n=116)	FSDP (n=122)	X ²	P
Pregnancy rate	67.2% (78)	72.1% (88)	0.674	.412
Lambing rate	64.7% (75)	63.9% (78)	0.013	.908
Single birth rate	94.7% (71)	73.1% (57)	13.037	.000
Twin birth rate	5.3% (4)	15.4% (12)	4.125	.042
Multiple birth rate	5.3% (4)	16.7% (13)	4.973	.026
Fecundity rate	1.05%	1.08%	0.306	.580
Lamb mortality rate at birth	3.8% (3)	9.5% (8)	2.121	.145

X²: Pearson chi-square value

RESULTS

The fertility parameters measured at the present study in HSDP and FSDP groups are given in Table 3. All pregnant ewes had ossification of head, ribs and vertebrae. Therefore, it was determined that all ewes were conceived in the first estrus after sponge withdrawal. Significant differences were noticed between groups in single lambing rate, twin and multiple birth rates. The percentage of sheep giving single birth in HSDP was higher in comparison to FSDP, whereas twin and triplet births were higher in FSDP group than in HSDP.

DISCUSSION

The aim of this study was to lower the twin and multiple birth rate in yearling sheep without lamb care experience or in herds in which multiple births are not generally preferred. It was hypothesised that this could be achieved by reducing the dose of PGF_{2α} from a full dose (75 µg) to a half dose (37.5 µg) in the routine synchronization protocol. Due to the farm and management conditions, natural breeding was performed and oestrous behaviours and breeding date were not recorded. Ultrasonographic examinations were used only for detecting pregnancy. The litter size was identified by considering lambs born per sheep. The results of this study have indicated that reducing HSDP in the routine synchronization protocol ensured similar pregnancy and lambing rates. These results have illustrated that HSDP is as satisfying as FSDP in terms of fertility, showing that reducing the dose of PGF_{2α} is a cost-effective method regarding the sheep farm management. In the current study, pregnancy rates in the treatment groups were found to be higher than those of other studies (Ataman et al., 2009; Altınçekic and Koyuncu, 2017; Altınçekic et al., 2018; Tajaddodchelik et al., 2020), probably because of different types and dose of gonadotrophins, breed differences, nutrition, duration of the treatment and age of

the animals.

The most significant finding of this study was the reduced twin and multiple birth rate and the increased single birth rate in the HSDP in comparison to FSDP. By reducing the dose of PGF_{2α}, a lower litter size can be yielded in yearling lambs and sheep herds in which no twinning was preferred. The lower litter size of HSDP might be a result of partial or inadequate luteolysis. Studies regarding effect of different doses of PGF_{2α} on luteolysis are available in the literature (Herrera et al., 1990; Juengel et al., 2000; Cerón et al., 2001; Granados-Villarreal et al., 2017). Therefore, it was observed that reduced dose of PGF_{2α} generally led to partial luteolysis and consequently higher levels of progesterone than control group (Juengel et al., 2000; Granados-Villarreal et al., 2017). Progesterone concentration resulting from partial luteolysis affects the oocyte quality negatively, consequently leading to persistent dominant follicles and affects the LH levels (Lonergan et al., 2011). In the case of subluminal or low progesterone level (1-2 ng/ml), frequency of LH pulses increases (Flynn et al., 2000). However, the increase in the LH pulse frequency is not sufficient for final maturation of dominant follicles and ovulation, leading to persistent dominant follicles (Flynn et al., 2000; Lonergan et al., 2011). Persistent follicles lead to low fertility due to early meiosis by the oocyte reaching metaphase II prior to ovulation. Capacity of these oocytes to fertilise are low. Even if fertilised, they have delayed development causing the increased rates of the embryonic loss at 2-16-cell-stage (Ahmad et al., 1995; Johnson et al., 1996). Vinales et al. (2001) reported that ovulation of persistent dominant follicles results in the lower pregnancy rates in the ewes.

In the current study, lower multiple and higher single birth rate in HSDP compared to FSDP might be resulted from subluminal progesterone concentration, increased LH pulse frequency, the persistent follicles

containing aged oocytes and increased embryonic loss. The higher single lamb rate can be quite advantageous in terms of lamb mortality. Therefore, this study has indicated that the reduced dose of the PGF_{2α} might be used to decrease the litter size in yearling Awassi ewes, thereby preventing lamb mortality due to litter size and inadequate maternal care of lambs. This treatment could be used in large flocks as there is no difference between HSDP and FSDP groups in terms of fertility parameters and total number of lambs. It has been demonstrated that in addition to eCG, PGF_{2α} can also be used as an alternative tool to control the fecundity rates in yearlings.

CONCLUSION

In brief, the administration of the half dose of PGF_{2α} to a routine synchronization protocol does not have a negative effect on fertility in Awassi yearlings following the end of the breeding season. Taking in mind

the results of this study, it was inferred that a half dose of PGF_{2α} together with eCG in a 7 days sponge protocol could be used as an alternative method in yearling lambs without experience in lamb care or herds in which multiple births are not generally preferred. It was considered that with further studies about this topic, a promising tool to control prolificacy in ewe could be improved.

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CONFLICT OF INTEREST

None declared by the authors.

REFERENCES

- Ahmad N, Schrick R, Butcher S, Inskeep E (1995) Effect of persistent follicles on early embryonic losses in beef cows. *BiolReprod* 52:1129-1135.
- Akcapinar H (1994) *Sheep Production*. First ed, Medisan Press, Ankara: pp 51-176.
- Alacam E (2007) Control of Breeding. In: *Obstetrics and Infertility of Domestic Animals*. 6th edition, Medisan Press, Ankara: pp 71- 80.
- Alacam E (2010) Examination of Female Genital Organ. In: *Obstetrics and Infertility of Domestic Animals*. 3rd edition, Medisan Press, Ankara: pp 55-68.
- Ali A, Hayder M (2007) Ultrasonographic assessment of embryonic, fetal and placental development in Ossimi sheep. *Small RuminRes* 73(1-3):277-282.
- Altınçekiç SO, Koyuncu M (2017) Comparison of effects of CIDR and prostaglandin applications on their productive performance of Kivircik ewes in anestrus. *J TekirdagAgricFac* 14(1):9-15.
- Altınçekiç SO, Koyuncu M, Duru S (2018) Effect on fertility of PMSG applications in different doses in addition to flushing in Kivircik ewes. *MediterrAgricSci* 31(1):87-91.
- Ataman MB, Aköz M, Fındık M, Saban E (2009) Induction of synchronized oestrus in Akkaraman cross-bred ewes treated with prostaglandin F2 alpha, norgestomet and sponges impregnated with different doses of fluorogestene acetate at the beginning transitional period. *KafkasUniv Vet FakDerg* 15(5):801- 805.
- Bangar YC, Pachpute ST, Nimase RG (2016) The survival analysis of the potential risk factors affecting lamb mortality in Deccani sheep. *J DairyVet Anim Res* 4(2):266-270.
- Binns SH, Cox IJ, Rizvi S, Green LE (2002) Risk factors for lamb mortality on UK sheep farms. *PrevVetMed* 52(3-4):287-303.
- Bülbül B, Kırbas M, Aktas AH, Köse M (2014) Investigation of accelerated lambing possibility of Anatolian merino sheep. *KafkasUniv Vet FakDerg* 20(1):19-26.
- Cam MA, Kuran M (2004) Effects of a single injection of hCGorGnRH agonist on day 12 post mating on fetal growth and reproductive performance of sheep. *Anim ReprodScience* 80(1-2):81-90.
- Cam MA, Kuran M, Yildiz S, Selcuk E (2002) Fetal growth and reproductive performance in ewes administered GnRH agonist on day 12 post-mating. *Anim ReprodScience* 72(1-2):73-82.
- Cerón JH, Méndez JV, Quintero LZ (2001) Regresión del cuerpóluteo y presentación del estro en ovejas con dos inyecciones de prostaglandina con 8 días de intervalo. *TécPecuMéc* 39(1):53- 57.
- Dwyer CM (2003) Behavioural development in the neonatal lamb: effect of maternal and birth-related factors. *Theriogenology* 59:1027-1050.
- Dwyer CM, Calvert SK, Farish M, Donbavand J, Pickup HE (2005) Breed, litter and parity effects on placental weight and placentome number, and consequences for the neonatal behaviour of the lamb. *Theriogenology* 63(4):1092-1110.
- Flaiban KKMC, Balarin MRS, Ribeiro ELA, De Castro FAB, Mori RM, Lisboa JAN (2009) Transferência de imunidade passiva em cordeiros cujas mães receberam dietas com diferentes níveis de energia ou proteína no terço final da gestação. *Ci Anim Bras*:181-185.
- Flynn JD, Duffy P, Boland MP, Evans ACO (2000) Prostaglandin synchronization in the absence of a corpus luteum results in the ovulation of a persistent follicle in cyclic ewe lambs. *Anim ReprodScience* 62(4): 285-296.
- Gama LT, Dickerson GE, Young LD, Leymaster KA (1991) Effects of breed, heterosis, age of dam, litter size, and birth weight on lamb mortality. *J Anim Sci* 69:2727- 2743.
- Gökçe E, Kırmızıgül AH, Erdoğan HM, Çitil M (2013) Risk factors associated with passive immunity, health, birth weight and growth performance in lambs: I. effect of parity, dam's health, birth weight, gender, type of birth and lambing season on morbidity and Mortality. *KafkasUniv Vet FakDerg* 19(Suppl A).
- Granados-Villarreal LM, Zarco L, Mejía O, Sánchez-Torres MT, Pablos-Hach JL (2017) Luteolytic efficiency of reduced doses of cloprostenol in the ewe. Effect of progesterone concentrations at the time of treatment. *Anim ReprodScience* 186:68-76.
- Herrera HL, Feldman SD, Zarco QL, Valencia MJ, Ortiz HA, Ángeles CS (1990) Evaluación del efecto luteolítico de la prostaglandina F2 alfa en diferentes días del ciclo estral de la borrega. *Vet Méx* 21(2):143-147.
- Huffman EM, Kirk JH, Pappaiouanou M (1985) Factors associated with neonatal lamb mortality. *Theriogenology* 24(2):163-171.
- Johnson SK, Dailey RA, Inskeep EK, Lewis PE (1996) Effect of peripheral concentrations of progesterone on follicular growth and fertility in ewes. *Dom Anim Endocrin* 13:69-79.
- Juengel JL, Haworth JD, Rollyson MK, Silva PJ, Sawyer HR, Niswender GD (2000) Effect of dose of prostaglandin F2α on steroidogenic

- components and oligonucleosomes in ovine luteal tissue. *BiolReprod* 62(4):1047-1051.
- Karaca F, Ataman MB, Cayan K (2009) Synchronization of oestrus with short-and long-term progestogen treatments and the use of GnRH prior to short-term progestogen treatment in ewes. *Small Rumin Res* 81(2-3):185-188.
- Kaymakçı M, Özder M, Karaca O, Torun O, Baş Z, Koşum N (2009) Turkey Breeding sheep strategy. *Bursa UludagÜniv Ziraat Fak Derg*23(2):67-77
- Kenyon PR, Maloney SK, Blache D (2014)Review of sheep body condition score in relation to production characteristics. *New Zealand J AgriculRes* 57(1):38-64.
- Khan TH, Hastie PM, Beck NFG, Khalid M (2003) hCG treatment on day of mating improves embryo viability and fertility in ewe lambs. *Anim ReprodScience* 76(1-2):81-89.
- Levy F, Keller M (2008) Neurobiology of maternal behavior in sheep. *AdvStudyBehav* 38:399-437.
- Lonergan P (2011) Influence of progesterone on oocyte quality and embryo development in cows. *Theriogenology* 76(9):1594-1601.
- Mousa-Balabel TM (2010)The relation ship between sheep management and lamb mortality. *World AcadSciEngTechnol* 41:1201-1206.
- Mutiga ER, Mukasa-Mugerwa E (1992)Effect of the method of estrus synchronization and PMSG dosage on estrus and twinning in Ethiopian Menze sheep. *Theriogenology* 38(4):727-734.
- Najafi G, Cedden F, Mojtahedi S, Aliverdinasab R (2014)Estrus synchronization and twinning rate of ghezel ewes treated with CIDR and PMSG during the breeding season. *Online J Anim FeedRes* 4(6):144-149.
- Nash ML, Hungerford LL, Nash TG, Zinn GM (1996) Risk factors for perinatal and postnatal mortality in lambs. *VetRec* 139(3):64-67.
- Padilla-Rivas GR, Sohnrey B, Holtz W (2005) Early pregnancy detection by real-time ultrasonography in Boergoats. *Small RuminRes* 58(1):87-92.
- Quintero-Elisea JA, Macías-Cruz U, Álvarez-Valenzuela FD, Correa-Calderón A, González-Reyna A, Lucero-Magaña FA, Soto-Navarro SA, Avendaño-Reyes L (2011)The effects of time and dose of pregnant mare serum gonadotropin (PMSG) on reproductive efficiency in hair sheep ewes. *Trop Anim HealthProd* 43(8):1567-1573.
- Refsauge G, Brien FD, Hinch GN, Van De Ven R (2015)Neonatal lamb mortality: factors associated with the death of Australian lambs. *Anim ReprodScience* 56(4):726-735.
- Scales GH, Burton RN, Moss RA (1986)Lamb mortality, birth weight, and nutrition in late pregnancy. *New Zealand J AgricRes* 29(1):75-82.
- Stevens D, Alexander G, Lynch JJ (2013) Lamb mortality due to inadequate care of twins by Merino ewes. In *Reproductive and Developmental Behaviour in Sheep*. 1st, ElsevierSciences, Amsterdam: pp 143-152.
- Suguna K, Mehrotra S, Agarwal SK, Hoque M, Singh SK, Shanker U, Sarath T (2008) Early pregnancy diagnosis and embryonic and fetal development using real time B mode ultrasound in goats. *Small RuminRes* 80(1-3):80-86.
- Tajaddodchelik A, Torun O, Ergün Y (2020) The effects of controlled internal drug release for different days on the reproductive performance of out of mating seasonsheep. *JAFEAS* 1(1):28-38.
- Viñoles C, Forsberg M, Banchero G, Rubianes E (2001) Effect of long-term and short-term progestagen treatment on follicular development and pregnancy rate in cyclic ewes. *Theriogenology* 55(4):993-1004.
- Yapi CV, Boylan WJ, Robinson RA (1990)Factors associated with causes of preweaning lamb mortality. *PrevVetMed* 10(1-2):145-152.