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Effects of Energy Level and PMSG Dose on Reproductive Performance of Zel Ewes Bred to Shal or Zel Rams

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Abstract: One hundred eighty four Zel ewes, 3-5 years of age were used to evaluate the effects of strategic supplementary feeding prior to mating and doses of PMSG to ewe synchronization on reproductive performance of Zel ewes mated to Zel or Shal rams. The ewes fed diets containing two levels of metabolizable energy, 2.0 or 2.3 Mcal kg^{-1} with 115 g kg^{-1} DM crud protein for 21 days prior to mating period. After 7 days of experiment, the ewes were synchronised with intra vaginal CIDR devices containing 1.9 g progesterone for 14 days. Ewes received 300 or 500 IU of PMSG injection at CIDR removal time and later mated with Zel or Shal ram. All important reproductive parameters such as ewe fertility, prolificacy, lambing rate, lamb mortality and twining measured. The results showed that Shal rams increased ewe fertility ($p<0.05$) but not affected by PMSG administration and flushing. Ewes bred to Shal rams had higher fertility compared to ewes bred to Zel rams. Prolificacy was not affected by PMSG administration but it was significantly affected by diet and ram ($p<0.05$). High dietary energy resulted in a higher prolificacy. Lambing rate changed with energy level and ram breed ($p<0.05$) and high level of energy increased lambing rate by 26%. Administration of 500 IU PMSG resulted in higher lamb mortality in compared to 300IU ($p<0.05$). High level of PMSG and flushing diet increased twining rate ($p<0.05$) but ram had no any effect on twining rate.

Key words: Ewe, flushing, reproductive performance, energy level, twining rate, prolificacy

INTRODUCTION

The sheep population in Iran estimated about 54 millions and mainly kept in extensive and semi-intensive system based on natural pastures (Osfoori and Fesus, 1996). Hence, their production level is generally low and suboptimal. There is an escalating need to modernize the current traditional system to accommodate the increase in sheep population. Furthermore, the poor productivity of sheep and their growth performance also contribute to insufficiency of lamb supply in Iran. Efficiency of production may increase through improvement of management to meet the lamb demand. These improvements include, e.g., nutrition and feeding management, reproduction and breeding management.

Nutrition is one of the most important factors affecting ovulation rate. For example, supplementation for 4-6 days with lupin grain, a high energy and high protein supplement is sufficient to increase the ovulation rate in sheep (Gherardi and Lindsay, 1982; Oldham and Lindsay, 1984; Stewart and Oldham, 1986). Also, flushing involves increasing the plane of nutrition before breeding to increase ovulation rate. Nutritional flushing as strategic supplementary feeding is performed to improve the body condition of ewes and to increase the body weight before and during mating while also increasing ovulation rate. The role of nutritional flushing should not be ignored, especially where estrus is induced and multiple births are the result. There is a paucity of information on the effect of nutritional flushing in high prolific breeds or in hormone treated flocks. The application of nutritional and reproductive strategies can assist to maximize the overall production efficiency of a flock (Weis *et al*., 2003; Esen and Bozkurt, 2001). Synchronization of oestrus cycle is a technique which is used to bring large number of animals in a flock into overt heat at the predetermined time. The technique offers an opportunity to increase the efficiency of animal production in different ways. It has been reported that PMSG can increase pregnancy and twinning rates in breeds characterized by low litter size. However, there are many factors influencing the effect of

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PMSG including the dose and administration time of PMSG and season. Several synchronization treatments incorporate an injection of a low dose of Pregnant Mare Serum Gonadotropin (PMSG) at the end of the progestagen treatment in order to obtain a more precise and reliable synchronization of estrus since it increases the occurrence of ovulation and improves the post-treatment fertility in small ruminants (Cognie, 1992; Maxwell, 1984). Therefore, rate of ovulation is affected by the PMSG dose level employed (Boland *et al*., 1981; Maxwell, 1984; Smith *et al*., 1981). Breeds or crosses that produce large lamb crops at an early age have the potential to increase efficiency and reduce costs (Dickerson and Laster, 1975).

Zel is smallest of the Iranian sheep breeds and is the only breed in the country that is not fat-tailed. Its origin is from the North of Iran, the Mazenderan area and Golestan province. In this region the climatic condition in Golestan province moderate with rainfall between 450-600 mm. In summer, the Zel flocks are moved to the pastures of the Alborz mountains nearby. Zel sheep represent 6.2% of the total sheep population in Iran. It is an important breed for meat production due to its lean meat with less fat but Zel ewes have small body weight. Shal is a pure fat-tailed breed kept under semi intensive production system.

The origin of this breed is in the region named Shal located in Qazvin province of Iran. This breed considered as the heavy weight breed. Therefore, it has been used as the terminal sire in a flock that produces lamb for fattening.

This study was undertaken to evaluate the effects of strategic supplementary feeding prior to mating (flushing) and doses of PMSG to ewe synchronization on reproductive performance of Zel ewes mated to Zel or Shal rams in Golestan province of Iran. The ultimate goal was to improve Zel sheep productivity in Golestan province and similar ecological areas.

MATERIALS AND METHODS

Experimental location: This experiment was carried out at Animal Breeding Research Centre of Shirang, Golestan province (36°50′N and 53°50′00″S). This centre is located at Northern of Iran, 35 km far from Gorgan with average rainfall of 560 mm and temperature between 0 and 45°C. The sheep farming facilities at this centre classified as intensive system where all sheep housed in the barn and receive feed and water within the house.

Animal management and experimental treatments: A total of 184 Zel ewes, 3-5 years of age and body weight of between 35 and 45 kg used in this experiment. The ewes fed diets containing two levels of metabolizable energy,

Table 1: Composition of diet fed to ewes 21 days prior to mating

Ingredient composition (g kg^{-1} DM)	HDE	NDE
Corn silage	570.0	710.0
Cotton meal	80.0	100.0
Wheat bran	70.0	140.0
Barley grain	270.0	40.0
Vitamin mix*	5.0	5.0
Mineral mix†	5.0	5.0
Nutrient composition		
Crude protein (g kg^{-1} DM)	115.0	115.0
Metabolizable energy (Mcal kg^{-1} DM)	2.3	2.0
Crud fiber (g kg^{-1} DM)	16.4	17.2
Ca (g kg^{-1} DM)	5.6	5.9
P (g kg^{-1} DM)	3.3	3.7

*Mineral mix: 1,500,000 IU kg^{-1} vitamin A, 400,000 IU kg^{-1} vitamin D and 6000 IU kg^{-1} vitamin E as guaranteed by the supplier. †Vitamin mix: 175 g kg^{-1} Ca, 75 g kg^{-1} Mg, 28.2 mg kg^{-1} Co, 2520 mg kg^{-1} Cu, 151 mg kg^{-1} I, 13,000 mg kg^{-1} Fe, 10,000 mg kg^{-1} Mn, 75 mg kg^{-1} Se and 10,000 mg kg^{-1} Zn as guaranteed by the supplier

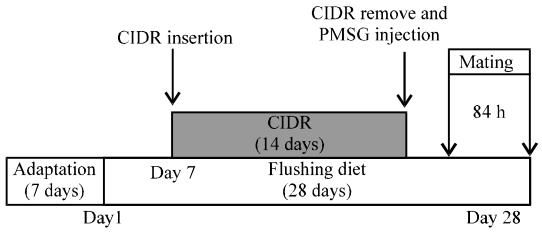

Fig. 1: Time schedule of synchronization and flushing

2.0 Mcal kg^{-1} (NDE: Normal Dietary Energy NRC, 1985) or 2.3 Mcal kg^{-1} (HDE, Flushing) and 115 g kg^{-1} DM crud protein for 21 days prior to mating period (Table 1).

After 7 days of experiment, the ewes were synchronised with intravaginal CIDR devices containing 1.9 g progesterone (CIDR, inter Ag, New Zealand) for 14 days (Fig. 1). Ewes received 300 or 500 IU of PMSG (Pregnecol, Bioniche, Australia; 20,000 IU/dose) injection at CIDR removal time and later mated with Zel or Shal ram. Half of the ewes in both flushing and NDE group bred to Zel and the other half bred to Shal rams 36 h post CIDR removal time.

The ratio of rams to ewes was 1:10 and the rams were selected to be healthy, aged between 3-4 years and proven sires. After 72 h of mating period, the ewes separated from the rams. Following the mating, ewe rations were composed of 115 g kg^{-1} DM CP and 2.0 Mcal kg^{-1} ME until 90 days. Ewe rations for late pregnancy were contained 115 g kg^{-1} DM CP and 2.2 Mcal kg^{-1} ME.

Totally, treatment groups shown in Table 2. Ewes fed twice daily (morning and evening) and the total amount of feed offered during the experimental period was calculated based on 3% of body weight in dry matter as presented by NRC (1985). Body weights of ewes recorded at the beginning and end of experimental period.

Table 2: Treatment groups in the experiment

Treatment	Diet	PMSG (IU)	Ram
1	Normal dietary energy	300	Zel
2	High dietary energy	300	Zel
3	Normal dietary energy	500	Zel
4	High dietary energy	500	Zel
5	Normal dietary energy	300	Shal
6	High dietary energy	300	Shal
7	Normal dietary energy	500	Shal
8	High dietary energy	500	Shal

Statistical analysis: Data were analyzed using the GLM procedure of SAS (1991). Data were subjected to ANOVA in 2×2×2 factorial design with the diet, PMSG and ram as main effects. The model included two diets (flushing and NDE), two PMSG levels (300 and 500IU) and two rams (Zel and Shal). The initial weight of the ewes was considered as a co-variant. Least square means were used to compare the significant levels between treatment groups. Significance level was declared at $p<0.05$.

RESULTS AND DISCUSSION

There were no significant interaction of ram x diet, ram x PMSG, PMSG x diet and ram x diet x PMSG for all the reproductive parameters measured in this experiment (fertility, prolificacy, lambing rate, lamb mortality and twins). Body weight of ewes was not different among treatment groups at the beginning of the experiment. Also, there was no significant difference in body weights of ewes in both ram and PMSG groups and at the end of the experiment. However, flushing resulted in significant difference in body weight of ewes, 40.1±1.6 and 35.6±1.8 kg, respectively for flushing and NDE group.

Reproductive parameters: Table 3-5 show the effects of flushing; PMSG and ram breed on reproductive parameters of ewe's, respectively. Ewe fertility not changed by dietary energy level however, fertility rate in ewes received high level of energy (flushing) tendency increased.

Ram had a significant effect on ewe fertility ($p<0.05$) but PMSG administration and flushing had no any significant effect. According to the result, ewes bred to Shal rams had highest fertility (91.25%) compared to ewes bred to Zel rams (74%). Prolificacy was not affected by PMSG administration but it was significantly affected by diet and ram ($p<0.05$). High dietary energy resulted in a higher prolificacy (132%).

Similarly, ewes mated with Shal rams showed 6% improvement in prolificacy compare to ewes mated with Zel rams. Lambing rate changed with energy level and ram

Table 3: Effects of flushing on reproductive parameters of ewes

	Diet			
Item (%)	Flushing	NDE	Sig. level	SEM
Fertility	85.7	79.3	NS	0.04
Prolificacy	132.0^a	109.0^b	*	0.05
Lambing rate	113.0^a	87.0^b	*	0.06
Lamb mortality at birth	7.7	7.2	NS	0.32
Twins	32.0^a	10.0^b	***	0.54

^{a,b}Means within columns sub-group with different superscripts are different; NS: Not Significant, *: $p<0.05$, **: $p<0.01$, ***: $p<0.001$

Table 4: Effects of PMSG on reproductive parameters of ewes

	PMSG (IU)			
Item (%)	300	500	Sig. level	SEM
Fertility	82.4	82.6	NS	0.04
Prolificacy	114.0	127.0	NS	0.05
Lambing rate	94.0	105.0	NS	0.07
Lamb mortality at birth	1.3^b	9.2^a	*	0.33
Twining	15.0^b	28.0^a	*	0.55

IU: International Unit, 300: PMSG 300IU, 500: PMSG 500 IU, SEM: Standard Error of Mean; ^{a,b}Means within columns sub-group with different superscripts are different; NS: Not Significant, *: $p<0.05$, **: $p<0.01$, ***: $p<0.001$

Table 5: Effects of ram breed on reproductive parameters of ewes

	Ram			
Item (%)	Zel	Shal	Sig. level	SEM
Fertility	74.2^b	91.2^a	**	0.09
Prolificacy	118.0^b	124.0^a	**	0.04
Lambing rate	88.0^b	112.0^a	**	0.05
Lamb mortality at birth	4.6	7.8	NS	0.25
Twins	19.0	25.0	NS	0.43

^{a,b}Means within columns sub-group with different superscripts are different; NS: Not Significant, *: $p<0.05$, **: $p<0.01$, ***: $p<0.001$

breed ($p<0.05$) and high level of energy increased lambing rate by 26%. This elevation marked in ewes bred with Shal rams by 24% compared to ewes bred with Zel rams. Administration of 500 IU PMSG resulted in higher lamb mortality (9.2%) in compared to 300 IU (1.3%) ($p<0.05$). Lamb mortality was not affected by diet and ram breed. High level of PMSG (500 IU) and flushing diet increased twining rate ($p<0.05$) but ram had no any effect on twining rate.

In this experiment no significant difference were observed in fertility rate although, there was a tendency to an improvement in fertility in the ewes received high dietary energy. Flushing increased fertility about 6% in compare to normal dietary energy group. These findings are in agreement with reports on dietary energy level intakes in other breeds and conditions (Mohajer, 1997; Maurya *et al*., 2004). The main aim of flushing is to increase reproductive performance of animals and this normally reflected by actual conception and lambing rates. Moreover, an aspect that could play an important role in flushing is not only the duration of flushing period but also time of administration and level of flushing is

important. Another interesting point of the results is the tremendous improvement in the twining of flushing group. Previous researches has shown a positive correlation of nutrition and reproduction efficiency in which Yoder *et al.* (1990) have reported that poor pastures decrease twin birth in mountain sheep. The greater the magnitude of the poor pastures, the more decline in the number of twin birth. West *et al.* (1991) and Mohajer (1997) reported that flushing has increased lamb twining and thus increase the reproductive performance of ewe. The application of nutritional and reproductive strategies can assist to maximize the overall production efficiency of a flock (Weis *et al.*, 2003; Esen and Bozkurt, 2001). In agreement, the results indicate that flushing effectively increased twining (22%) and consequently lambing rate (26%). The PMSG treatment appeared to have no significant effect on fertility, lambing rate and prolificacy (Table 4). However, administration of PMSG significantly increased twining rate and lamb mortality. Evidently, twining rate increased from 15% in ewes received 300 IU PMSG to 28% in ewes received 500 IU PMSG. This findings in agreement with the result of Lubbadeh (1986) which reported that Awassi ewes in Jordan that treated with sponges plus PMSG had a twinning rate of 42% compared with 12% for untreated and 10% for sponge without PMSG groups.

Therefore, PMSG is required to stimulate follicular growth leading to higher oestrus response (Greyling and van Niekerk, 1991). However, the lack of significant PMSG effects on lambing rate, prolificacy and fertility, indicate that the protocol of PMSG administration need to be further localized under the experimental condition. To achieve the optimum result by PMSG administration, some researcher incorporated the use of Norgestomet implants with PMSG for out season breeding. The results varied slightly to that of natural mating but little known about using Norgestomet implants without PMSG to synchronize ewes during the natural breeding season. Ram breed significantly influenced fertility, prolificacy and lambing rate (Table 5). The results showed that lambing rate, prolificacy and fertility increased in Zel ewes mated with Shal ram in compare to Zel ewes mated with Zel ram by 24, 6 and 17%, respectively. This elevation in lambing rate of crossbred ewes was resulted from their higher fertility. Generally high performance of the Shal, especially for lambing rate is consistent with other reports that have evaluated different sheep breeds and crosses (Quirk *et al.*, 1988; Freking *et al.*, 2000). The ewes mated with Shal ram had higher prolificacy than ewes mated with Zel ram. The high prolificacy in the Shal crossbred lambs could be attributed to a combination of high milk production and motherhood behavior of Zel ewes and high genetic merit of Shal ram to growth. Freking *et al.* (2000) investigated the effect of five ram breed (Dorset, Finnsheep, Romanov, Texel and Montadale) on the reproductive parameters. Their results indicated a superior reproduction performance in Romanov-sired crosses due to greater conception rate and prolificacy for each mating season and ewe age. They proposed several explanations for this phenomenon such as ram preference to mate or aggressiveness of ewes to mate with Romanov rams. It seems that the same conception could be extrapolated regarding the higher fertility and prolificacy of Shal ram x Zel ewes.

CONCLUSION

It appears that administration of PMSG with dosage of 500 IU is effective to increase twining in Zel ewes. It also reveals that the flushing protocol used in the present study may enhance prolificacy, lambing rate and twining in Zel ewes. Lastly, it may conclude that mating program with Shal as ram and Zel as ewe successfully increase fertility, prolificacy and lambing rate. However, further experiments needed to optimize the flushing and PMSG administration protocol and strengthen these results as a practical recommendation for commercial farming.

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