



Reproductive performance and lamb's birth weight in Ossimi ewes treated with organic selenium and nano-selenium under Upper Egyptian condition

Abd-Elkareim M. F. A.^a, Ali M. E.^{a*}, Fahmy S.^a, Hussein A. H.^b

^aDepartment of Animal Productions, Faculty of Agriculture, Al-Azhar University, 71524 Assiut, Egypt

^bDepartment of Theriogenology, Faculty of Veterinary Medicine, Assiut University, 71526 Assiut, Egypt

Abstract

The goal of this study was to assess reproductive performance, estrus signs, and lamb's birth weight in Ossimi ewes treated with organic selenium and Nano-selenium under Upper Egyptian conditions. In this experiment, a total of 30 ewes were divided into three equal groups (10 ewes /each). All of the animals were given intra-vaginal sponges (IVS) impregnated with medroxy-progesterone-acetate (MAP, 40 mg) for 14 days. Then, in the G1: (CG) control group, and the ewes in G2 (SeG) were given organic selenium 3 mg/ewe orally for 14 days from insert IVS, whereas the ewes in G3: (N-SeG) were given Nano-selenium 0.2 mg/animal orally for 14 days from insert IVS. Also, after 50±5 days of parturition (post-partum), the ewes divided randomly into 3 equal groups (10 ewes/each), and managed with the same previous treatments. The results showed that ewes given organic selenium and Nano-selenium had longer ($P<0.01$) in estrus duration and took a shorter ($P<0.01$) period to show estrus than control group in both the first service and post-partum. In addition, during the first service and post-partum, the estrus response in SeG and N-SeG were significantly higher ($P<0.05$) than CG. However, the intensities of estrus signs as swollen vulvar lips and redness of the vaginal membranes were clearly apparent on the ewes in SeG and N-SeG compared to the CG. Also, the body weight of lambs born from ewes treated with organic selenium and Nano-selenium increased significantly ($P<0.01$) compared to the control group. The body weight of the lambs in N-SeG was higher ($P<0.01$) after 15 days of parturition than in CG. In conclusion, treatment with organic selenium and Nano-selenium could improve the reproductive performance, estrus signs, and lamb birth weight in ewes under Upper Egyptian climatic conditions.

Keywords: ewes, estrus response, conception rate, nano-selenium, organic selenium.

*Corresponding author: Ali M. E.,
E-mail address: montaser_elsayd@azhar.edu.eg

1. Introduction

Small ruminants have a unique niche in smallholder agriculture because they have shorter production cycles and faster growth rates, are easier to manage, require less investment capital, have a lower risk of loss, require less feed, and are more adaptable to harsh environmental climates than large ruminants (Ahuya *et al.*, 2009; FAO, 2008). However, under semi-intensive production systems successful estrus synchronization programs could improve lambing rate efficiency and fecundity rates, resulting in increased profitability for sheep owners (Knights *et al.*, 2003). Also, intra-vaginal sponges (IVS) are used for 12 or 14 days to approximate the length of a normal luteal phase and guarantee that the spontaneous corpus luteum (CL) is present before the IVS is removed. After the IVS removal 75% to 100% of the ewes enter into estrus within 24^{hrs} to 72^{hrs} according to Olivera-Muzante *et al.* (2011). In addition, organic Selenium is more effective in ruminants than inorganic Selenium (Kumara *et al.*, 2009), while the latter is more hazardous (Doucha *et al.*, 2009). Selenium is a mineral that aids in the growth, metabolism, and reproduction of animals. Selenium deficiency, on the other hand, can result in decreased fertility, placental retention, and abortions according with

Grela and Sembratowicz (1997). Nanoparticles, defined as particles with a diameter of 1 to 100 nanometers, are an interesting class of materials having properties intermediate between the molecular and bulk scales, also, nanotechnology is the next industrial revolution, according to studies, and it is expected to have a substantial impact on society, the economy, and life in general in the present and future. This technology has a significant impact on a variety of sectors, including energy, chemistry, medicine, genetics, and biotechnology (Ingle *et al.*, 2008). As a result, new physical and chemical features emerge, such as increased cellular uptake, reactivity, surface area, and charge, as well as binding properties that may be useful (Casabianca, 2020). In human medicine, nanotechnology is employed to generate diagnostic and therapeutic agents, but its applicability in animal medicine and manufacturing is still limited (Pieczyńska and Grajeta, 2015). Selenium nanoparticles have been employed as a reactive oxygen species (ROS) scavenger in various investigations to protect against oxidative damage (Khalil *et al.*, 2019). Endometrial alterations in distinct luteal phases, folliculogenesis, ovulation, fertilization, placental growth, embryogenesis, and implantation are all influenced by the balance of ROS and antioxidants in

female mammalian species, according to previous research (Al-Gubory *et al.*, 2010). Therefore, this study aimed to compare reproductive performance, estrus signs, and lamb birth weight in synchronized Ossimi ewes treated with nano-selenium and organic selenium under intensive production in Upper Egyptian climatic conditions.

2. Materials and methods

2.1 Study location and experimental animals

All Institutional and National Guidelines for the care and use of animals were followed according to the Egyptian Medical Research Ethics Committee (No. 14–126). The current study was carried out at farm belonging to the Faculty of Agriculture, Al-Azhar University, Assuit, Egypt. A total thirty Ossimi ewes were included in this study. The ewes were 3–4 years and weighing 49.5 ± 5.03 Kg. The ewes were housed in open barns with sheds during the experimental periods. The animals were clinically healthy, free from reproductive disorders and fed on daily farm ration, water, and a mineral supplement was available add libitum and feed a daily farm ration (14 % protein). The ewes were assigned randomly into three equal groups (10 ewes/each), all animals received intra-vaginal sponges (IVS) impregnated with medroxy-progesterone-acetate, MAP 40 mg. (MAP, Pfizer manufactured, NV/SA, Puurs, Belgium) for 14 days. In the G1:

(CG), ewes served as control. Ewes in the G2: (SeG) was dosed with organic selenium 3 mg/ewe orally for 14 days from IVS inserts according with Ali, (2009) and Musa *et al.* (2018). And the G3: (N-SeG) were received nano-selenium 0.2 mg/ewes orally for 14 days from IVS insert according to Stefanov *et al.* (2018). The same managements and treatment as the previous were applied at 50 ± 5 day's post-partum and the placenta dropped normally.

2.2 Reproductive performance

2.2.1 Estrus detection

Heat detection was performed daily by visual observation and using three fertile rams in good health condition (2 to 3 years) for breeding during the estrus days after the removal of the sponges, the fertile ram was introduced after 24^{hrs} of the IVS removal twice every day on the morning and night, till the end of the estrus the ewe stands firmly to be mounted with the ram, it will be considered in estrus and the following parameters were recorded.

2.2.2 Onset of estrus

Onset estrus is the time (hours), from the end of the preceding treatments till the appearance of estrus signs (Zonturlu *et al.*, 2011).

2.2.3 Estrus duration

Defined as the period of sexual receptivity and mating which

characterized by distinct behavioral symptoms of estrus and estimated from first to last signs of estrus (Jarquin *et al.*, 2014).

2.2.4 Ewe's signs of estrus

All estrus signs (intensity of estrus signs) that appear on the ewes will be recorded as movement, urination, swollen vaginal lips and redness vaginal membrane.

2.2.5 Measures of fertility

Fertility was measured according to Zeleke *et al.* (2005):

$$\text{Estrus response} = \frac{\text{ewes comes into estrus}}{\text{ewes treated}} \times 100$$

$$\text{Conception rate} = \frac{\text{ewes conserved}}{\text{ewes inseminated!}} \times 100$$

$$\text{Lambing rate} = \frac{\text{lamb born}}{\text{ewes pregnancy}}$$

2.3 Statistical analysis

Statistical analysis of the data obtained in the study was performed by using the Statistical Package for the Social Sciences (SPSS) computer programs (2006), method of analysis (Snedecor and Cochran 1982). Significant differences among sub-class means were analyzed by Duncan's multiple range tests (Duncan, 1955). Differences between the groups were calculated with the ANOVA test. Estrus, conception, lambing, fecundity rates and estrus signs in the groups were statistically evaluated using the chi-squared test.

3. Results

3.1 Reproductive performance

Data presented in Table (1), revealed that ewes treated with organic selenium (SeG) and Nano-selenium (N-SeG) had higher ($P < 0.01$) period in estrus (estrus duration) and it took a shorter ($P < 0.01$) period to come into estrus than control group (CG) in the first service and post-partum after the intra vaginal sponges withdrawn. Also, there were significance higher, in the duration ($P < 0.05$) and onset of estrus ($P < 0.01$) when comparing the first service and post-partum regardless of the treatment, and there was no statistical difference in the interaction between treatments and time in the duration and onset estrus. The estrus response (Table 1), in the SeG and N-SeG had a significance higher ($P < 0.05$) than CG in the first service (90% and 90% vs. 60%, respectively) and post-partum (90% and 80% vs. 60%, respectively). While there was non-significant effect in the conception rate within groups in the first service (50%, 80% and 80% in G1, G2 and G3, respectively) and post-partum time (50%, 70% and 70% in G1, G2 and G3, respectively). However, in the ewes treated with organic selenium and Nano-selenium had higher lambing rate than control group in the first service (1.20 and 1.30 vs. 1.10, respectively) and post-partum (1.20 and 1.20 vs. 1.00 respectively)

but was non-significance. Furthermore, there were no statistical difference in the interaction between groups and time (whether the first service or post-partum) in the estrous and conception rate and lambing rate.

Table (1): Impact of manipulating ewes with organic selenium (SeG) and nano-selenium (N-SeG) on estrus duration, onset estrus, estrus response, conception rate and lambing rate at first service and post-partum.

Treatments	Estrus			Conception rate (%)	Lambing rate
	Duration (hours)	Onset (hours)	Response (%)		
Effect of treatment (T) at first service					
Control (CG)	29.60±1.18 ^a	73.35±3.89 ^b	60 ^b	50	1.10
Selenium (SeG)	39.00±1.19 ^b	54.30±3.75 ^a	90 ^a	80	1.20
Nano-selenium (N-SeG)	38.10±1.17 ^b	52.95±3.22 ^a	90 ^a	80	1.30
Effect of treatment (T) at Post-partum					
Control (CG)	30.80±1.55 ^a	77.10±3.16 ^b	60 ^b	50	1.00
Selenium (SeG)	37.20±1.20 ^b	52.20±4.11 ^a	90 ^a	70	1.20
Nano-selenium (N-SeG)	39.00±2.04 ^b	52.20±2.99 ^a	80 ^a	70	1.20
Effect of time (A)					
First service	35.47±1.34	59.9±3.85	83	70	1.20
post-partum	35.67±1.13	60.50±2.91	77	63	1.13
Probability					
First service (T)	**	**	*	*	*
Post-partum (T)	**	**	*	*	*
Effect of time (A)	NS	NS	NS	NS	NS
Interaction (T×A)	NS	NS	NS	NS	NS

^{a,b} means with different superscripts in the same column, NS = not significant. * = probability (P < 0.05), ** = probability (P < 0.01), CG = control group, SeG = organic selenium group and N-SeG = nano-selenium group.

3.2 Estrus signs

The ewes during pro-estrous showed movement, urination, swollen vaginal lips and redness vaginal membrane but they refused the male during teasing, and the estrus confirmed by complete receptivity to the ram. In the current study in Table (2), the estrus signs had more (P < 0.05) intense in the ewes treated with organic selenium (69%) and nano-selenium (57%) than control group (41%). While there were no statistical differences between first service and post-partum (50% and 61%, respectively) within groups in intense estrous behavior. Also, there were significant

(p < 0.05) differences between SeG and N-SeG than CG in the frequent movement. While urination (0.75 and 0.55 vs. 0.40%), swollen vaginal lips (0.75 and 0.60 vs. 0.40%) and redness vaginal membrane (0.30 and 0.30 vs. 0.25%), in SeG and N-SeG had clearly visible signs than CG but, were non-significant. In the general, the interaction between groups (SeG, N-SeG and CG) and time (first service and post-partum) did not show statistical differences.

3.3 Birth weight and lambs body weight

Table (3) showed that the body weight of lambs born from ewes treated with

organic selenium (SeG) and Nano-selenium (N-SeG) increased significantly ($P<0.01$) compared to the control group (CG). Also, after 15 days of pregnancy, the body weight of the lamb's N-SeG was significantly higher ($P<0.01$) than lamb's CG, but the body weight of the

lambs within groups were not significantly different after 7 days of pregnancy. However, there was no significant difference in the body weight of lambs born from SeG or N-SeG ewes in the first service, post-partum and there was no interaction.

Table (2): Impact of manipulating ewes with organic selenium (SeG) and nano-selenium (N-SeG) on estrus signs (%) at first service and post-partum.

Treatments	Estrus signs (%)				
	Movement	Urination	Swollen vaginal lips	Redness vaginal membrane	Intensity of estrus signs
Effect of treatment (T)					
Control (CG)	0.60±0.11	0.40±0.11	0.40±0.11	0.25±0.10	0.41±0.11
Selenium (SeG)	0.95±0.05	0.75±0.10	0.75±0.10	0.30±0.11	0.69±0.10
Nano-selenium (N-SeG)	0.80±0.09	0.55±0.11	0.60±0.11	0.30±0.11	0.57±0.10
Effect of time (A)					
First service	0.83±0.07	0.63±0.09	0.63±0.09	0.33±0.09	0.61±0.09
Post-partum	0.73±0.08	0.50±0.09	0.53±0.09	0.230.08	0.50±0.08
Probability					
Treatment (T)	*	*	*	NS	*
Effect of time (A)	NS	NS	NS	NS	NS
Interaction (T×A)	NS	NS	NS	NS	NS

NS = no significant. *= probability ($P<0.05$), CG = control group, SeG = organic selenium group and N-SeG = nano-selenium group.

Table (3): Impact of manipulating ewes with organic selenium (SeG) and nano-selenium (N-SeG) on birth weight and lambs body weight after 7 and 15 days (Kg) of pregnancy at first service and post-partum.

Treatments	Birth Weight (Kg)	After 7 days (Kg)	After 15 days (Kg)
Effect of treatment (T)			
Control (CG)	3.13±0.16 ^b	6.64±0.16	8.56±0.18 ^b
Selenium (SeG)	3.96±0.13 ^a	7.13±0.17	9.22±0.23 ^{ab}
Nano-selenium (N-SeG)	4.15±0.12 ^a	6.75±0.17	9.04±0.20 ^a
Overall mean	3.75±0.09	6.84±0.10	8.94±0.12
Effect of time (A)			
First service	3.92±0.14	6.79±0.15	9.02±0.18
Post-partum	3.58±0.13	6.90±0.13	8.87±0.16
Overall mean	3.75±0.09	6.84±0.10	8.94±0.12
Probability			
Treatment (T)	**	NS	**
Effect of time (A)	NS	NS	NS
Interaction (T×A)	NS	NS	NS

^{a,b} means with different superscripts in the same column, NS = no significant. **= probability ($P<0.01$), CG = control group, SeG = organic selenium group and N-SeG = nano-selenium group.

4. Discussion

The ewes in SeG and N-SeG had significant longer estrus duration and

ewes in both groups get into estrus earlier than that in CG during the first service and post-partum. Likewise, the ewes treated with SeG and N-SeG showed

higher conception rate and lambing rate than CG (80% and 80% vs. 50%) and (1.20 and 1.30 vs. 1.10, respectively). The obtained results were in agreement with that reported by Sánchez *et al.* (2008) who found that the conception and lambing rate in the ewes supplemented with selenium were higher than untreated ewes; also, they reported that the conception rate and lambing rate increased from 60% to 80%, and 1.07 to 1.12 per ewe, respectively. Also, the ewes in SeG and N-SeG had a higher estrus response than CG. According to Koyuncu and Yerlikaya (2007) the administration of Se by intramuscular injection had positive effects on the incidence of estrus, fertility and prolificacy in ewes, also, observed that such injections increased fecundity by 1.31 when compared to their control group. Previous studies have been reported that Se deficiency in ewes may cause embryonic deaths at 20–30 days after ovulation in ewes and pre-breeding Se administration around the time of conception reduces embryonic mortality (Hartley, 1963). In contrast to our results, no effect on conception rates in Awassi ewes but its increased lambing rates after only one selenium service (Awawdeh *et al.*, 2019). These effects may be linked to selenium's role as an intracellular antioxidant, which protects cellular membranes from oxidative damage by scavenging reactive oxygen species, (Barchielli *et al.*, 2022). Selenium is a cofactor in the glutathione peroxidase enzyme system, which is responsible for

extracellular free radical detoxification (Smith *et al.*, 2010). However, Wu *et al.* (2011) demonstrated the importance of maternal administration of selenium at Nano-size for improving the hair follicle development and promoting the growth of fetus, this was attributed to the influencing antioxidant status in the fetal skin. One of the most important trace elements for improving reproductive and physiological processes is nano-selenium particles (Zhang *et al.*, 2006). Use of nanotechnology could be efficient to attain bioactive properties of different elements including nano-selenium in reproduction (Pelyhe and Mezes, 2013). Nano-Se has been efficiently functioned on animal growth, reproduction, and immunity systems (Shi *et al.*, 2009). Intensities of estrus signs (movement, urination, and swollen vaginal lips) in sheep treated with SeG were 69% and Nano-SeG (57%) compared to CG (41%). According to Mujawar *et al.* (2019) in buffaloes treated with selenium the estrus intensity was high in 37.50%, intermediate in 50.00% and weak in 12.50%. These findings are similar to those published by Chaudhary *et al.* (2015), and Wani *et al.* (2018). The severity of estrus in buffaloes treated with Ovsynch plus vitamin E and Selenium was high in 12.50%, intermediate in 75.00%, and mild in 12.50%. These findings are closely related. The expression of estrus, for example, requires an appropriate balance between estradiol, progesterone, and perhaps the androgens as well (Signoret,

1975), and improve the follicular diameter in the ewes synchronized with intra-vaginal sponges impregnated with MAP (Ali *et al.*, 2018). It may be a reason to improve the intensity of estrus in this study. Lambs' body weight rose in SeG and N-SeG in the day of parturition, after 7 and 15 days, compared to the CG. In addition, its body weight of the lamb was in-significance during the first service and post-partum. According to Koyuncu and Yerlikaya (2007), the intramuscular injection of Se has a considerable favorable effect on the live weight gains of lambs up to 60 days of age. Also, Gabryszuk and Klewicz (2002) found that treated with selenium had a beneficial influence on lamb fertility, prolificacy and body weight. The birth weight of lambs in SeG and N-SeG did not significance. There is a link between low Se concentrations at the early stages of pregnancy and low birth weight in sheep (Freer and Dove, 2002) and humans (Pieczyska and Grajeta, 2015). Nutritional abnormalities, such as Se deficiency, have been shown to reduce fetal growth and lamb birth weight in survival by limiting placental capacity (Freer and Dove, 2002). According to our findings, Se deficiency may not be severe enough to limit placental growth and reduce lamb birth weight. Even though, another study found that adding Se to ewe's diet has no influence on lamb birth weight (Sánchez *et al.*, 2008; Van *et al.*, 1992), which is surprising. In this study, the differences between the ewes treated with organic

selenium (SeG) and those treated with nano-selenium (N-SeG) were non-significant and the results were closely similar.

5. Conclusion

The value of this study is that it indicates that the administration with organic selenium and nano-selenium which will result in an increase in the economic efficiency of the sheep and an increase in the income of the breeders by increase the reproductive performance in ewes. So, we recommended to use organic selenium and Nano-selenium as additives for ewes to improve reproductive characteristics, production rates and lambs' weight.

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